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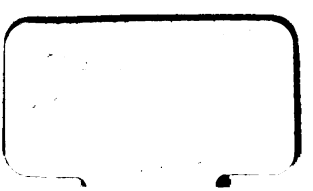

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TRANSACTIONS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

VOL. IV.

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TRANSACTIONS

OF THE

HERTFORDSHIRE

NATURAL HISTORY SOCIETY

AND

FIELD CLUB.

EDITED BY JOHN HOPKINSON, F.L.S., F.G.S.

VOLUME IV.

OCTOBER, 1885, TO OCTOBER, 1887.

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,, 3.	,, 65–96	....	October, 1886.
,, 4.	,, 97–128	....	January, 1887.
,, 5.	,, 129–160	....	April, 1887.
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,, 7.	,, 193–224	....	November, 1887.
,, 8.	,, ix–lii	....	April, 1888.
,, 9.	,, i–viii, and 225–232	....	June, 1888.

Dates of publication of previous volumes:

TRANSACTIONS OF THE WATFORD NATURAL HISTORY SOCIETY.

Vol. I.	(pp. lxiv and 248).....	August, 1878.
,, II.	(pp. lx and 260)	June, 1880.

TRANSACTIONS OF THE HERTFORDSHIRE NATURAL HISTORY SOCIETY.

Vol. I.	(pp. lxviii and 272)	May, 1882.
,, II.	(pp. lxviii and 286)	May, 1884.
,, III.	(pp. lxxii and 274)	March, 1886.

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PROCEEDINGS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

ORDINARY MEETING, 20TH OCTOBER, 1885, AT WATFORD.

Professor ATTFIELD, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

Mr. Daniel Hill and Mr. E. H. Hoddinot were elected Members of the Society.

Mr. John Hartley Durrant, F.E.S., Merton Hall, Thetford; Mr. F. Freeman, Lattimore Road, St. Albans; Mr. J. Upfield Green, Liebenheim, Watford; Mr. W. Hare, London Road, St. Albans; and Mr. Rodway C. J. Swinhoe, Church Road, Watford, were proposed as Members.

The following lecture was delivered:—

"The Adventures of an Ornithologist in Siberia." By Henry Seebohm, F.L.S., F.Z.S.

ORDINARY MEETING, 17TH NOVEMBER, 1885, AT WATFORD.

Professor ATTFIELD, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

Mr. John Hartley Durrant, F.E.S.; Mr. F. Freeman; Mr. J. Upfield Green; Mr. W. Hare; and Mr. Rodway C. J. Swinhoe, were elected Members of the Society.

The following lecture was delivered:—

"Snakes and Snake-bites." By Arthur Stradling, C.M.Z.S.

ORDINARY MEETING, 1ST DECEMBER, 1885, AT WATFORD.

Professor ATTFIELD, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

The following paper was read:—

"On Mosses." By E. Morell Holmes, F.L.S. (Communicated by A. E. Gibbs.)

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ORDINARY MEETING, 11TH DECEMBER, 1885, AT HERTFORD.

Professor ATTFIELD, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

Mr. John Henry Buxton, Hunsdon Bury, Ware, and the Rev. J. D. Parker, LL.D., Bennington Lodge, Stevenage, were proposed as Members of the Society.

The following lecture was delivered :—

"The Great Essex Earthquake of the 22nd of April, 1884." By Professor R. Meldola, F.R.A.S., F.I.C., F.C.S. (*Transactions*, Vol. IV, p. 23.)

ORDINARY MEETING, 15TH DECEMBER, 1885, AT WATFORD.

Professor ATTFIELD, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

Mr. John Henry Buxton and the Rev. J. D. Parker, LL.D., were elected Members of the Society.

The following paper was read :—

"On *Melicerta ringens*; a chapter from the great Book of Nature as revealed by the Microscope." By John Badcock, F.R.M.S. (Communicated by F. G. Lloyd, Hon. Sec.) (*Transactions*, Vol. IV, p. 33.)

A number of living animalculæ provided by Mr. Francis Ransom were exhibited under microscopes by Mr. J. E. Groome, Mr. Hopkinson, and Mr. Lloyd, in illustration of the lecture.

ORDINARY MEETING, 26TH JANUARY, 1886, AT WATFORD.

Professor ATTFIELD, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

The Honourable Mrs. Barnett, Edge Grove, Aldenham, Watford, was proposed as a Member of the Society.

The following paper was read :—

"On a Diagram for a Model of the Solar System to scale." By Arthur Cottam, F.R.A.S. (*Transactions*, Vol. IV, p. 97.)

ORDINARY MEETING, 2ND FEBRUARY, 1886, AT WATFORD.

Professor ATTFIELD, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

The Honourable Mrs. Barnett was elected a Member of the Society.

The Rev. T. G. Gibbons, M.A., Rome Land, St. Albans, was proposed as a Member.

The following lecture was delivered :—

"Plants and their Uses." By John R. Jackson, A.L.S.

Mr. R. P. Blathwayt and Mr. Daniel Hill were elected Auditors of the accounts for 1885.

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Anniversary Meeting, 16th February, 1886.

(At Watford.)

Professor Attfield, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

Benjamin Daydon Jackson, Sec. L.S., 2, Thorncliffe Road, Clapham Park, London, S.W., was elected an Honorary Member of the Society.

The Report of the Council for 1885, and the Treasurer's Account of Income and Expenditure, were read and adopted.

The President delivered an Address on "The Laws of God in Nature." (*Transactions*, Vol. IV, p. 1.)

The following gentlemen were duly elected as the Officers and Council for the ensuing year:—

President.—Professor John Attfield, Ph.D., F.R.S., F.I.C., F.C.S.

Vice-Presidents.—Alfred T. Brett, M.D.; F. Maule Campbell, F.L.S., F.Z.S., F.R.M.S.; Richard B. Croft, R.N., F.L.S., F.R.M.S.; the Right Honourable the Earl Cowper, K.G.; John Evans, D.C.L., LL.D., F.R.S., Pres.S.A., F.L.S., F.G.S., etc.; John Hopkinson, F.L.S., F.G.S., F.R.M.S., F.R.Met.Soc.

Treasurer.—Charles R. Humbert.

Honorary Secretaries.—Frederick G. Lloyd and C. E. Shelly, B.A., M.B.

Librarian.—F. Haycraft Berry, M.B.

Curator.—William Verini.

Other Members.—Allan Barraud; A. P. Blathwayt; Alfred Fowell Buxton; Arthur E. Gibbs; Daniel Hill; T. Mark Hovell, F.R.C.S.; John E. Littleboy; John Morison, M.D.; F. W. Phillips, F.L.S.; George Rooper, F.Z.S.; Frank W. Silvester, F.R.Met.Soc.; Arthur Stradling, C.M.Z.S.

The thanks of the Society were then accorded to Mr. William Ransom, F.L.S., and Mr. George Rooper, F.Z.S., retiring from the office of Vice-President; to Mr. R. B. Croft, R.N., F.L.S., retiring from the office of Honorary Secretary; to Mr. Allan Barraud retiring from the office of Librarian; and to Mr. E. M. Chater and Mr. John Weall retiring from the Council.

Report of the Council for 1885.

In presenting the Eleventh Annual Report, the Council of the Hertfordshire Natural History Society and Field Club can again congratulate the members upon the increased amount of work done, as shown by the large number of papers and lectures read or delivered during the year, embracing a very wide range of subjects, several of which were by some of the highest authorities in their respective branches of Natural History, and also upon the increased interest taken by the members, as shown by their larger attendances at both the Ordinary and Field Meetings.

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During the year nineteen ordinary members and two honorary members have been elected; three members have compounded for their annual subscription; twenty-two members have resigned, and the Council regrets to have to record the loss of three ordinary members and one honorary member by death. The census of the Society at the end of the years 1884 and 1885 was:—

	1884.	1885.
Honorary Members	18	19
Life Members	42	44
Annual Subscribers	211	202
	271	265

The following papers and lectures have been read or delivered during the year:—

Jan. 6, at Watford.—The Nests and Eggs of Birds; by Henry Seebohm, F.L.S., F.Z.S.

—— 20, at Watford.—The Origin and Constitution of Chalk and Flint; by Prof. T. Rupert Jones, F.R.S., F.G.S.

Feb. 3, at Watford.—Indian Snakes and Snake-charming; by Sir Joseph Fayrer, M.D., K.C.S.I., LL.D., F.R.S., etc.

—— 17, at Watford.—Anniversary Address; by the President, the Right Honourable the Earl Cowper, K.G.

—— 19, at Hertford.—List of Works on the Geology of Hertfordshire, 1874-83; by John Hopkinson, F.L.S., F.G.S.

—— Some Hertfordshire Well-Sections; by W. Whitaker, B.A. (London), F.G.S., Assoc.Inst.C.E.

March 3, at Watford.—Diatoms, their Nature and Habits; by Francis Ransom.

—— Notes on Birds observed in Hertfordshire during the year 1884; by John E. Littleboy.

—— 24, at Watford.—Meteorological Observations taken at Wansford House, Watford, during the years 1883 and 1884; by John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

—— Report on Phenological Phenomena observed in Hertfordshire during the years 1883 and 1884; by John Hopkinson.

—— Notes on a Whirlwind at Ivinghoe, 11th Sept., 1834; by John E. Littleboy.

—— List of Flowering Plants observed in Hertfordshire during the year 1884; by Ada Selby.

—— List of Lepidoptera observed in the neighbourhood of Hitchin, and at Stevenage; by John Hartley Durrant, F.E.S.

—— Note on a Curious Habit of the Wagtail; by J. Henry James.

April 15, at Hertford.—Meteorological Observations taken at Throcking, Herts, during the year 1884; by the Rev. C. W. Harvey, M.A., F.R.Met.Soc.

—— Report on the Rainfall in Hertfordshire during the year 1884; by the Rev. C. W. Harvey.

—— Report on Insects observed in Hertfordshire during the year 1884; by F. W. Silvester, F.R.Met.Soc.

Oct. 20, at Watford.—Adventures of an Ornithologist in Siberia; by H. Seebohm, F.L.S.

Nov. 17, at Watford.—Snakes and Snake-bites; by Arthur Stradling, C.M.Z.S.

Dec. 1, at Watford.—On Mosses; by E. M. Holmes, F.L.S.

—— 11, at Hertford.—The Great Essex Earthquake of the 22nd of April, 1884; by Prof. R. Meldola, F.R.A.S., F.I.C., F.C.S.

—— 15, at Watford.—A Chapter from the Great Book of Nature, as revealed by the Microscope; by J. Badcock, F.R.M.S.

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The following Field Meetings were held during the year:—

March 26.—Aldbury and Ashridge Park.
April 11.—Rickmansworth and Cheneys.
May 16.—Hertford and Ware.
June 20.—Cassiobury Park, Watford.
July 11.—Watford and Rickmansworth.
Oct. 17.—Bricket Wood.

Two of these meetings were held in conjunction with other Societies; that on the 16th of May with the Geologists' Association, and that on the 11th of July with the Quekett Microscopical Club.

The meeting on the 26th of March was a Cryptogamic Meeting, and that on the 17th of October was the Third Annual Fungus Foray. On both occasions Dr. Braithwaite, F.L.S., and Mr. E. M. Holmes, F.L.S., kindly gave their services, accompanying the members and identifying the Mosses and other Cryptogamic plants met with.

The Society is indebted for hospitality kindly afforded at Field Meetings, to the President, Professor Attfield, F.R.S., at Watford, and to Mr. T. F. Buxton at Easneye Park, Ware. The Society is also indebted to the Earl of Essex for permission to visit the private grounds of Cassiobury House at the Cassiobury Park meeting.

In addition to the above Field Meetings, visits were paid on the 25th of April to the Zoological Gardens, Regent's Park, when Dr. P. L. Sclater, F.R.S., the Secretary of the Society, gave a most interesting lecture on Marsupials and Edentates; and on the 28th of May to Kew Gardens, where Mr. John R. Jackson, A.L.S., gave some very interesting explanations of various specimens in the Museum of Economic Botany.

Four parts of the Society's 'Transactions,' containing 172 pages and one plate, have been issued during the year, and two parts, one of which is already printed and the other in the press, completing the present volume, will soon be in the hands of Members.

The new Library Catalogue (of 52 pages) has been completed and issued, but, in place of a subject-index, your Editor, with the approval of the Council, has given an index of the names of the authors. The subject-index had been prepared, but, as the catalogue itself is classified, it was considered that an index to the authors, while taking up much less space, would be more useful. About 650 separate works and 300 pamphlets are catalogued, and the names of nearly 500 authors are indexed. The number of *volumes* in the library is nearly 1200.

The late Mr. A. R. Pryor's 'Flora of Hertfordshire' is at last in the hands of an able and experienced botanist, Mr. B. Daydon Jackson, Botanical Secretary of the Linnean Society, whose services your Editor has been successful in securing. The whole of Mr. Pryor's MS. intended for publication has been copied by Mr. A. E. Gibbs, the original MS. being kept intact. The first four sheets (of 16 pages each) have already been printed, and a considerable further portion is in the press, so that there is every probability of the work being brought to a satisfactory conclusion within a reasonable time.

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The library is in a satisfactory condition, and numerous books have been received during the past year by donation or exchange. A third bookcase has, by permission of the Public Library Committee, been placed in the lecture-room. In this case the books to which members will most often refer have been placed, with the exception of works on botany, which, with the valuable collection of books bequeathed to the Society by the late Mr. A. R. Pryor, are contained in the other two cases. Some of the latter are of exceptional value or rarity, and are not allowed to circulate without the special permission of the Council. A list of these exceptions will be found at the commencement of the Catalogue.

Your Secretary for East Herts resigns after having held that office since 1880. The Council desire on the occasion of Mr. Croft's retirement to place on record their high appreciation of his services to the Society for the period of five years.

In conclusion the Council has to express the thanks of the Society to the Committee of the Watford Public Library for the accommodation afforded for your Library and the Watford meetings.

Additions to the Library in 1885.

Presented.

Title.	Donor.
Anon. First Outlines of Inorganic Chemistry. 8vo. London, 1862.	*Mr. J. Hopkinson.*
——. Marine Botany and Seaside Objects. 8vo. London, N.D.	,,
Blanford, W. T. Address to the Geological Section of the British Association. 8vo. Montreal, 1884.	,,
Bonney, Prof. T. G. Address delivered at the Anniversary Meeting of the Geological Society, Feb. 1885. 8vo. London, 1885.	*The Author.*
Cooke, G. A. Topographical and Statistical Description of the County of Hertford. 12mo. London, N.D.	*Mr. J. Hopkinson.*
Cooke, M. C. (Ed.) Grevillea. Vol. xiii, Nos. 67-70. 8vo. London, 1885.	*The Editor.*
Evans, Dr. John. Physiography. 8vo. London, 1885.	*The Author.*
Glaisher, J. Meteorology of England during the quarters ending June 1858 to Dec. 1869, and March to Dec. 1871.	,,
Hicks, J. J. Illustrated and Descriptive Catalogue of . . . . Meteorological Instruments. 8vo. London, N.D.	*Mr. J. J. Hicks.*
Holmes, T. V. Miscellaneous Notes on Deneholes, 1883. (*Trans. Essex Field Club*, 1884.).	*The Author.*
Homersham, S. C. London (Watford) Spring Water Company. Map showing the situation of proposed Works for supplying London . . . . with pure Spring Water. Folio. 1852.	*Dr. A. T. Brett.*
Linnean Society. Journal. Botany. Vol. xxi, No. 137. 8vo. London, 1885.	*Mr. R. B. Croft.*
Lucretius Carus, Titus. De Rerum Natura libri sex. 12mo. Cambridge, 1675.	*Mr. J. Hopkinson.*
Moseley, H. N. Address to the Biological Section of the British Association. 8vo. Montreal, 1884.	,,
Ormerod. Eleanor A. Report of Observations of Injurious Insects . . . . during the year 1884. 8vo. London, 1885.	*The Authoress.*

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INCOME AND EXPENDITURE FOR THE YEAR ENDING 31st DECEMBER, 1885.

Dr.	£	s.	d.
To Balance from 1884	61	3	1
,, Life Compositions	15	0	0
,, Entrance Fees	9	10	0
,, Subscriptions for 1882	1	0	0
,, ,, ,, 1883	1	10	0
,, ,, ,, 1884	5	10	0
,, ,, ,, 1885	61	11	6
,, ,, ,, 1886	15	1	0
,, Dividend on £203 4s. 6d. Consols (less Income Tax)	5	17	10
,, Interest on £100 on deposit at London & County Bank	1	16	1
,, Sale of 'Transactions'	2	3	6
	£180	3	0

Cr.	£	s.	d.
By Printing 'Transactions'	53	3	7
,, Miscellaneous Printing	9	15	0
,, Expenses of Meetings	7	15	0
,, Library	23	11	0
,, Salary of Assistant	6	0	0
,, Postages	15	2	1
,, Stationery	1	1	7
,, Sundry small Expenses	2	7	8
,, Expenditure on the 'Flora of Hertfordshire'	13	11	3
,, Balance at Bank	47	15	10
	£180	3	0

Amount invested in the purchase of £203 4s. 6d. Consols ..... £198 15s.
,, on deposit at the London and County Bank ..... 100 0s.

Audited and found correct, this 13th day of February, 1886, { A. P. BLATHWAYT, DANIEL HILL.

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TITLE.	DONOR.
PRESTON, Rev. T. A. Results of 20 Years' Observations on Botany, Entomology, Ornithology, and Meteorology taken at Marlborough College, 1865-84. Folio. . .	*The Author.*
——. (Ed.) Wiltshire Rainfall, 1882-84. 3 vols. Folio. Marlborough, 1883-85.	*The Editor.*
RAYLEIGH, Lord. [Presidential] Address, British Association for the Advancement of Science, Montreal, 1884. 8vo.	*Mr. J. Hopkinson.*
ROSCOE, Prof. H. E. Address to the Chemical Section of the British Association, Montreal, 1884. 8vo. . .	,,
RUTOT, A. Compte Rendu de l'excursion de la Société Géologique de Belgique dans les environs de Bruxelles . . . . 8vo. Liege, 1881.	*Dr. A. T. Brett.*
——. Sur la position stratigraphique des restes de mammifères terrestres recueillis dans les couches de l'éocéne de Belgique. 8vo. Bruxelles, 1881.	,,
——. Note sur les observations nouvelles faites aux environs de Bruxelles, Castre, et Renaix. *Ib.* 1882. .	,,
——. Les alluvions modernes dans la Moyenne Belgique (*Bull. de Musée Royal d'hist. nat. de Belg.* 1882). 8vo.	,,
——. Les Phénomènes de la sédimentation marine . . . . (*ib.* 1883.) 8vo.	,,
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Ordinary Meeting, 25th February, 1886, at Hertford.

Professor Attfield, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

The following paper was read:—

"The Germ Theory of Disease." By C. E. Shelly, B.A., M.B., Hon. Sec.

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Several kinds of Microbes alluded to by Mr. Shelly were exhibited under microscopes in illustration of his paper.

ORDINARY MEETING, 16TH MARCH, 1886, AT WATFORD.

Professor ATTFIELD, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

The Rev. T. G. Gibbons, M.A., was elected a Member of the Society.

The following paper was read:—

"Wild Plants: their Attributes and Names." By F. G. Lloyd, Hon. Sec. (*Transactions*, Vol. IV, p. 105.)

ORDINARY MEETING, 18TH MARCH, 1886, AT HERTFORD.

RICHARD B. CROFT, Esq., R.N., F.L.S., F.R.M.S., Vice-President, in the Chair.

Mr. A. F. Griffith, Elmfield, Hertford, and Mr. Horace J. Tuck, St. Holmes, Bengeo, Hertford, were proposed as Members of the Society.

The following paper was read:—

"An Account of British and Roman Remains found in the Neighbourhood of Hitchin. By William Ransom, F.L.S. (*Transactions*, Vol. IV, p. 39.)

Diagrams and specimens were exhibited by Mr. Ransom in illustration of his paper.

ORDINARY MEETING, 20TH APRIL, 1886, AT WATFORD.

JOHN HOPKINSON, Esq., F.L.S., F.G.S., etc., Vice-President, in the Chair.

Mr. A. F. Griffith and Mr. Horace J. Tuck were elected Members of the Society.

Mr. W. R. L. Lowe, Hatfield Road, St. Albans; Mr. E. F. Noel, Manor House, Stanmore; Miss F. Sullivan, Lemsford Road, St. Albans; and Mr. T. J. Villiers, Watford, were proposed as Members.

The following papers were read:—

1. Report on Insects observed in Hertfordshire during the year 1885." By F. W. Silvester, F.R.Met.Soc. (*Transactions*, Vol. IV, p. 49.)

2. "Notes on Birds observed in Hertfordshire during the year 1885." By John E. Littleboy. (*Transactions*, Vol. IV, p. 53.)

ORDINARY MEETING, 29TH APRIL, 1886, AT HERTFORD.

F. M. CAMPBELL, Esq., F.L.S., F.Z.S., F.R.M.S., Vice-President, in the Chair.

The following papers were read:—

1. Meteorological Observations taken at Throcking, Herts, during the year 1885." By the Rev. C. W. Harvey, M.A., F.R.Met.Soc. (*Transactions*, Vol. IV, p. 65.)

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2. "Report on the Rainfall in Hertfordshire in 1885." By the Rev. C. W. Harvey. (*Transactions*, Vol. IV, p. 73.)

3. On a Diagram for a Model of the Solar System to Scale." By Arthur Cottam, F.R.A.S. (*Transactions*, Vol. IV, p. 97.)

Mr. Campbell called attention to the alleged breeding of the woodcock in Hertfordshire, and showed the eggs from a nest found on Cow Heath.

Field Meeting, 8th May, 1886.

ST. PETER'S, ST. ALBANS.

From St. Peter's Church, the place of meeting, the members proceeded to Bernard's Heath, where various sections of the Woolwich and Reading Beds exposed in the brickfields were inspected, and some account of them was given by Dr. John Morison, F.G.S. No fossils, he said, were found in these beds here, but they were fossiliferous in some places, and their fossils being partly freshwater and partly marine proved them to have been deposited at the estuary of a great river. The Chalk upon which these beds rest, and of which an exposure was seen at one point in the brickfields, was, Dr. Morison stated, an essentially deep-sea formation, and was principally composed of the shells of minute animals called Foraminifera.

The ancient earth-work known as Beech Bottom was then visited, and in this narrow glade the somewhat rare golden saxifrage (*Chrysosplenium oppositifolium*) was found growing, with the more abundant wood-anemone, blue-bell, and other wild flowers.

Here Mr. A. E. Gibbs, F.L.S., made a few remarks on the origin of Beech Bottom. Of its history, he said, nothing definite was known, but it was obviously an ancient earth-work of considerable extent, and it bore a great resemblance to the ditch known as the Devil's Dyke which divides the parishes of Wheathampstead and Sandridge a few miles to the north-east. "Beach" was most probably its more correct name, being derived, not from the beech tree, but from the Danish *Bakke*, a hill or margin, for the word "beach" was formerly applied not only to the sea-shore, but to any gravelly bank. Beech Bottom was in some places twenty to thirty feet deep, having banks covered with undergrowth, and it presented much the same appearance for about a mile in a north-easterly direction, forming a portion of an earth-work which must have enclosed a considerable tract of country. In the 'Archæological Journal' for 1865 Mr. S. Sharpe stated his conclusion that "the fortified area was about two miles and a quarter long and three-quarters broad, enclosing the town of St. Albans . . . From the west end of Beech Bottom" he says, the fosse met the River Ver "opposite St. Michael's Church; this being its north-west limit. The south-eastern side begins at Sopwell Mills on the same river, passing by Camp House. It then turns to the north, crosses Hatfield Road, and joins the north-west end of Beech Bottom at

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Sandridge Road. But," he adds, "this last portion was that which from want of footpaths I was not able to trace with satisfaction." Mr. Gibbs then compared the situation with Cæsar's account of a British camp he took by assault after crossing the Thames, and showed that it corresponded, being protected by woods and marshes. Such, however, was the usual position of British towns in those days.

In returning to St. Albans, Hall Place, the residence of Miss Lydekker, was, by her permission, visited, and an old guest-chamber at the top of the house was inspected. In the grounds are some trees not often met with, including a tulip-tree, a variegated sycamore, and a Judas tree (*Circis siliquastrum*) probably planted in the reign of Queen Anne.

The party then proceeded to Elmsleigh, the residence of Mr. S. Monckton White, who very kindly provided tea, and the thanks of the Society having been tendered to him by the President, Professor Attfield, F.R.S., the meeting was brought to a close.

Ordinary Meeting, 11th May, 1886, at Watford.

Professor Attfield, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

Mr. W. R. L. Lowe, Mr. E. F. Noel, Miss F. Sullivan, and Mr. T. J. Villiers were elected Members of the Society.

Mr. J. E. K. Cutts, Silverdale, Bushey Grove, Watford, was proposed as a Member.

The following papers were read:—

1. "Meteorological Observations taken at Wansford House, Watford, during the year 1885." By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc. (*Transactions*, Vol. IV, p. 83.)

2. "Report on Phenological Phenomena observed in Hertfordshire during the year 1885." By John Hopkinson. (*Transactions*, Vol. IV, p. 93.)

3. "The Earthquake in the West of England felt at Hertford." By C. E. Shelly, B.A., M.B. (*Transactions*, Vol. IV, p. 116.)

4. "Section of the Well and Boring made at the Colne Valley Water Works, Watford, in 1885." By William Verini. (*Transactions*, Vol. IV, p. 116.)

5. "Section at the St. Albans New Water Works" (from the 'Herts Advertiser'). Communicated by John Hopkinson. (*Transactions*, Vol. IV, p. 117.)

6. "Section at the Sewage Farm, Watford Fields." By A. T. Brett, M.D. (*Transactions*, Vol. IV, p. 117.)

7. "List of Flowering Plants observed in Hertfordshire during the year 1885." By Ada Selby. (*Transactions*, Vol. IV, p. 118.)

8. "On *Araucaria imbricata* bearing Cones." By A. T. Brett, M.D. (*Transactions*, Vol. IV, p. 118.)

9. "Notes on Reptiles recently observed near Watford." By Arthur Stradling, C.M.Z.S. (*Transactions*, Vol. IV, p. 119.)

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10. "Notes on Badgers (*Meles taxus*) in Hertfordshire." By A. T. Brett, M.D. (*Transactions*, Vol. IV, p. 119.)

11. "Note on a Fox-terrier catching an Eel." By J. P. Gwynne. (Communicated by Dr. Brett.) (*Transactions*, Vol. IV, p. 120.)

Field Meeting, 15th May, 1886.

WELWYN.

Outliers of the Lower Tertiaries, consisting of the Woolwich and Reading Beds and the London Clay, are scattered over the Chalk beyond the north-western margin of the London Tertiary Basin, chiefly in a line running from north-east to south-west, a few miles from, and roughly parallel with, the edge of this basin. A few, however, are met with at a greater distance, thus attesting the former extension of the Tertiaries over a very large area from which they have been removed by denudation. Of the principal line of outliers, two are in the neighbourhood of Welwyn, one (the Ayot outlier) being to the south-west, and the other (the Datchworth outlier) to the east of this town. The former of these it was the chief object of the present meeting to visit and examine.

The members assembled at half-past eleven at Welwyn Station, where they were met by members of the Geologists' Association of London, Mr. Hopkinson acting as Director for both Societies.

A chalk-pit on the hill-side above and north of Tewin Water was first visited. The Chalk here, seen from its lines of flints to be the Upper Chalk, comes nearly to the surface. Having no covering of clay, "pipes" may be expected to occur in it; and an apparently interstratified bed of clayey sand, with worn black flints below it, was assumed to have been formed by the lateral spreading out of a "pipe" descending in an oblique direction, so that only this section of it was visible.

Tewin Water Park, the seat of Mr. George Burnand, F.G.S., was then entered, and by his permission the pretty woodland walk by the side of the River Mimram was taken as far as the footpath, which, crossing it by a rustic wooden bridge, leads into the main road from Welwyn to Hertford. Returning on this road towards Welwyn, a large gravel-pit, excavated in the hill-side to the south of the valley, was entered. The gravel is of Middle Glacial age, being the "gravel of the lower plain" of Professor Hughes. Here and there are seen in it patches of boulder-clay. Before leaving this pit the Director gave an exposition of the various views held with regard to the deposition of the glacial beds in this neighbourhood, and the origin of the valleys, but as the subject has been fully discussed by Mr. Elsden in his paper on the "Post-Tertiary Deposits of Hertfordshire," * it need not here be further alluded to.

Passing by Digswell Water and under the Great Northern viaduct, Digswell Park was entered, and the church, dedicated to St. John the Evangelist, was visited. The walk was then con-

* 'Trans. Herts Nat. Hist. Soc.,' Vol. I, Part 3, p. 103.

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tinued through the park and the adjoining Rectory grounds, distant views of hilly woodland scenery calling forth remarks on the dependence of this scenery upon the geological structure of the country. At Sherrard's Park Wood the Tertiary outlier already alluded to was encountered, a deep cutting in the line from Hatfield to Dunstable exposing a section of the Reading Beds reposing upon the Chalk and overlaid by boulder-clay and pebble-gravel. The Ayot brickfield was then entered, and a good section of the London Clay and Reading Beds was seen. This section, described by Mr. Whitaker in his memoir on the 'Geology of the London Basin,' * is as follows:—

Sandy contorted pebble-gravel (at highest parts), 8 or 10 feet shown, but a greater thickness said to have been found.

London Clay. Brown clay, sometimes laminated, 8 or 10 feet shown, but as much as 14 feet said to have been found.

London Clay. Basement-bed. Brown loam, mostly with green grains; a bed of pebbles, about 3 inches thick, at or near the bottom, 4 to 4½ feet.

Reading Beds. Light-coloured sand, for the most part white, but partly brown and buff, with thin layers of pale grey clay; false-bedded at one place. The uppermost 6 or 12 inches sometimes clayey and ferruginous; the middle part sometimes with lines of pebbles "mostly well rounded, but some not, mostly black, but some green-coated" (*Topley*), 14 feet shown, but said to have been worked to a depth of 20 feet without reaching the Chalk.

The section was now clear to the Chalk, a depth of about 24 feet of sand being exposed. The false-bedding was very evident.

After a few fossils had been found, and more had been "acquired" in the cottage of a labourer near, the members walked to Welwyn, visiting a chalk-pit on the way; and at Welwyn a gravel-pit in the Middle Glacial, at about the same horizon as the one previously visited.

Some time was then spent in the church, which is chiefly interesting as being the scene of the labours of Dr. Young. In the old rectory near by he wrote his celebrated 'Night Thoughts.' In his time Welwyn was celebrated as a watering-place, a mineral spring, then considered to be of some value, rising in a corner of his garden, and he welcomed visitors to it and for them built an Assembly Room. The present rectory is on the other side of the Mimram, the grounds of each running down to the opposite banks of the river.

In the grounds of the present rectory, where the Rector, Canon Wingfield, received the party, is Mr. Blow's bee-garden, which was inspected under his guidance. The rectory was then entered, and the members of the two Societies were most hospitably entertained at tea by the Rector and Mrs. Wingfield, to whom a vote of thanks was accorded on the proposition of Dr. John Evans, F.R.S., seconded by Dr. P. L. Sclater, F.R.S.

The members then returned to Welwyn Station, having made a circuit from it of seven or eight miles.

* 'Mem. Geol. Survey,' vol. iv, p. 237.

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Field Meeting, 20th May, 1886.*

HATFIELD AND COLE GREEN.

Field Meeting, 5th June, 1886.

ST. STEPHEN'S, ST. ALBANS.

This meeting was held in conjunction with the St. Albans Architectural and Archæological Society, and was under the direction of Mr. Silvester. From the London and North-western Station the party crossed the fields to St. Julian's, where Mr. A. E. Gibbs gave an account of the Leper's Hospital, and the Rev. H. Fowler exhibited a copy of an old map of the Manor of St. Julian's on which the position of the hospital was indicated.

St. Stephen's Vicarage was then visited, the members of the two Societies being received by the Vicar, the Rev. W. D. W. Dudley, who exhibited a hexagonal glass cinerary urn and other Roman remains discovered in the churchyard, and conducted the party over the church, explaining the objects of interest in it. Remarks on the history of the church were also made by the Rev. H. Fowler and the Rev. Dr. Griffith.

A visit was then paid to Mr. A. Godman's apiary, where the process of making foundation-wax for the use of the bees was seen.

Leaving St. Stephen's, a walk was taken along the Watling Street to the Verulam Woods, where the Rev. Dr. Griffith gave an account of the old city of Verulam. The ancient Roman walls seen in these woods, he said, stood close by one of the more ancient British roads or trackways—the Watling Street—which, after passing London from the coast of Kent, entered Hertfordshire near Sulloniacæ on the Brockley Hills, and traversed much the same line as the Roman road afterwards did, by Medburn, Colney Street, New Park Bury, Cobden Hall, Park Street, St. Julian's, St. Stephen's, and past Gorhambury Park to Redbourn and Markyate Street, leaving our county near Dunstable and continuing on to Holyhead. Along this road the ancient Britons had fortified places at Sulloniacæ, here, and at Maiden Bower, near Dunstable. The old British town near this spot was probably the capital of Cassivellaunus, defended by forest-wood and by marshes, which the Romans under Julius Cæsar took in the year 54 B.C. But these walls, he thought, were probably those constructed by the Romans when they re-built Verulam after the insurrection under Queen Boadicea.

After the walls and earthworks had been examined, the members of the two Societies visited Westminster Lodge, where they were entertained at tea by Mr. and Mrs. I. N. Edwards.

* The Editor was not present at the Field Meetings of which no reports are given, and has been unable to obtain accounts of them.

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Field Meeting, 10th June, 1886.

BROXBOURNE AND THE RYE HOUSE.

From Broxbourne Station, the party, under the direction of Mr. R. T. Andrews, went over the mill-stream and under the railway, obtaining a good view of Broxbourne church, and then crossed the River Lea where the county boundary was pointed out. The road between the meads and marsh was taken to the "four-want-way" from Waltham to Roydon and Nazing to Broxbourne, and, on arriving at Nazingbury, from a little hill, a fine view of the country on the Hertfordshire side of the boundary was obtained.

Nether Hall was then visited and an account of it was given by Mr. Andrews. He stated that it was a mile and a half south of the Rye House and half a mile from the junction of the Rivers Lea and Stort, which form the north-western boundary of the ancient royal forest of Epping. The mansion was pulled down in 1773, the gateway only, a good specimen of Tudor architecture, being left standing because of the expense of destroying it. After giving a description of the old mansion, he traced the history of the manor from 1401 to the present time.

From Nether Hall the party proceeded to the foot of Sow Hill, and then over the meadows and by the banks of the Stort and Rattey's Lock to the Rye House, returning home by train.

The following are some of the plants gathered in the course of the walk and determined by Mr. Andrews:—

Batrachium pseudo-fluitans, Pryor.
Papaver Rhœas, L.
Lychnis Flos-cuculi, L.
Lathyrus pratensis, L.
Rubus cæsius, L.
Rosa canina, L.
Heraclium Sphondilium, L.
Symphytum officinale, L.
Myosotis palustris, Relh.
Veronica Beccabunga, L.
Rhinanthus minor, Ehrh.
Hottonia palustris, L.
Plantago media, L.
Chenopodium Bonus-Henricus, L.
Carex riparia, Curt.
,, *distans*, L.
,, *vulpina*, L.
Alopecurus geniculatus, L.
Glyceria fluitans, R. Br.
Briza media, L.
Equisetum limosum, L.
Ophioglossum vulgatum, L.

Field Meeting, 12th June, 1886.

WATFORD.

Field Meeting, 26th June, 1886.

PINNER.

The extension of the Metropolitan Railway from Pinner to Rickmansworth has exposed here and there sections of the London Clay, of the Woolwich and Reading Beds, and of the Chalk. The object of this meeting was to examine the sections of the Lower Tertiaries from Pinner to their escarpment near Moor Park, leaving the Chalk exposed at Rickmansworth for a future visit.

The place of meeting was the point where the line crosses the road to Rickmansworth, and here the members were met by members of the Geologists' Association, with the Director, Mr. Hopkinson.

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Before the line arrives at this point there is a shallow cutting, and almost immediately beyond it there is a much deeper cutting, both being in the London Clay. A little further on the basement-bed is exposed, having the usual bed of flint-pebbles very largely developed; and then, near Goose Green, just beyond the highest point, which is about 260 feet above the sea-level, the Woolwich and Reading Beds crop out under the escarpment of the London Clay. A small stream rises here and has had to be diverted almost from its source to allow of the line being carried in the direction of its bed nearly to the point where it flows into the River Colne. The line now emerges from the cutting, being continued to Rickmansworth on an embankment.

At this point, where the cutting ends, the line runs through a wood. Taking advantage of the shade afforded, for it was a hot sunny day, the Director gave a brief outline of the geology of the district which had been traversed, in the course of which he said that the chief point of geological interest was the inlier of the Woolwich and Reading Beds which occupies a considerable area of a very irregular outline around and for a mile or two west of the village. There appeared to have been a slight elevation of the Tertiary beds under Pinner (as shown in the section) extending for some distance in a line roughly parallel with the escarpment of these beds. Owing to this elevation and the lowering of the ground by the denuding action of a small stream, the course of which has probably been mainly determined by a line of weakness or breaking across of the strata caused by the elevation, the Reading Beds have been laid bare, appearing on the surface surrounded by the main mass of the London Clay. This "Pinner Inlier," as had been pointed out by Mr. Whitaker,* is in a line of elevation running from Windsor to Northaw, and giving rise to the Chalk hill on which Windsor Castle stands, and to the "Northaw Inlier" of the Reading Beds and the Chalk. About three miles to the north-west of this line of elevation is the Tertiary escarpment, and again a few miles to the north-west are a number of Tertiary outliers on the Chalk; the inliers, the escarpment, and the outliers being probably due to slight changes in the dip of the underlying Chalk in approximately parallel lines running south-west and north-east, such as would be caused by a crumpling of the strata by compression exerted in a north-west and south-east direction.

The line was left at Moor Park Farm, and the members of the two Societies walked by Hamper Mills, where the Colne was crossed, to Watford. At Watford House Dr. Brett entertained the party, tea and other refreshments being partaken of, and his collection of fossils, etc., being inspected. The Platts, the residence of Mrs. Bishop, was next visited, and an extensive series of minerals and fossils collected by her was examined with much interest.

* 'Geological Magazine,' vol. iv, p. 487.

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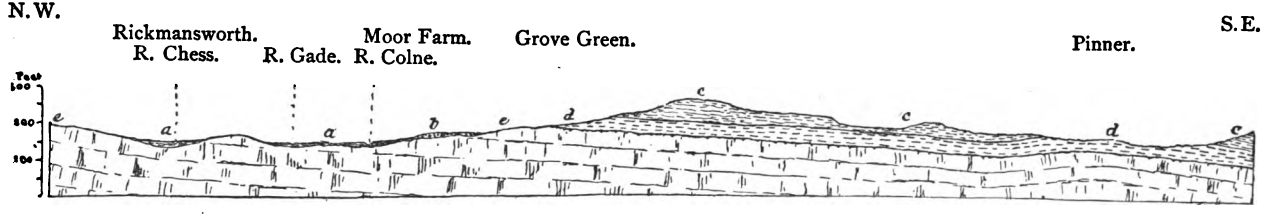
SECTION ALONG THE NEW LINE FROM PINNER TO RICKMANSWORTH.



a. Alluvium. *b.* Brick-earth. *c.* London Clay. *d.* Reading Beds. *e.* Chalk.

Horizontal Scale : 1 inch = 1 mile. Vertical Scale : 1 inch = 528 feet.

The level of the line is approximately (from aneroid measurements) 190 feet above Ordnance Datum at Pinner, 230 feet at the highest point, near Grove Green, and 200 feet at Moor Farm.

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Field Meeting, 1st July, 1886.
BROXBOURNE.

Field Meeting, 3rd July, 1886.
KING'S LANGLEY.

Field Meeting, 8th July, 1886.
BEDFORD.

Occasionally in the field meetings of the Hertfordshire Natural History Society the limits of the county are transgressed, but not before has the county boundary been passed for such a distance as on this visit to Bedford. The object of the meeting was to study the geology of the neighbourhood in connection chiefly with the water-supply of the town.

On their arrival at the Midland Station at a quarter-past eleven, the members were met by Mr. Edwin Ransom, Mayor of Bedford, and other members of the Bedfordshire Natural History Society.

The Pumping Station of the Bedford Water Works was first visited, and Mr. Ransom stated that the water-supply of Bedford was derived from a cut or "heading" in the Great Oolite limestone, starting from the pumping-well, at about 15 feet below the surface, and being carried eastwards almost level, for a distance of 789 feet, to a point where it is 51 feet below the surface. In 1867, he said, a boring of 100 feet was made, but for the last 75 feet it was entirely in clay. The heading was commenced in 1870, and extended in 1874 and 1885, and it cuts the water-bearing limestone at an angle of about 45 degrees.

Samples of the water as supplied to the town after passing the filter-beds, and of the water in the adjacent River Ouse, were taken by Professor Attfield, who has analysed them and finds that they contain per gallon the following grains and decimal parts of a grain of the respective substances:—

	Town water.	Ouse water.
Total solid matter, dried at 248° F.	48·00	29·00
Ammoniacal matter yielding 10 per cent. of nitrogen	0·04	0·04
(= ammonia per million	0·07	0·07)
Albumenoid organic matter yielding 10 per cent. of nitrogen	0·07	0·07
(= ammonia per million	0·12	0·12)
Nitrites	none	none
Nitrates containing 17 per cent. of nitrogen	none	traces
(= grains of nitrogen per gallon	none	traces)
Chlorides containing 60 per cent. of chlorine	4·30	2·80
(= grains of chlorine per gallon	2·60	1·70)
Hardness reckoned as chalk grains or "degrees":		
removed by ebullition	14·00	10·00
unaffected by ebullition	14·50	4·50
Total hardness	28·50	14·50
Lead or copper	none	none

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With reference to these analyses Professor Attfield makes the following remarks:—

"The water from the waterworks, being obtained from the natural accumulations in the adjacent oolitic limestone, contains a few grains per gallon of the substances which the rain always dissolves from such limestone, namely, chalk and a little magnesian matter, which give hardness to the water, some saline materials of unimportant character, and a trace of organic matter, which, though in a somewhat larger proportion than naturally occurs in most non-oolitic waters, does not render the water either better or worse for drinking purposes. That is to say, if such a proportion of organic matter is demonstrably yielded by the Oolite and not by surface impurities, then all experience warrants the opinion that its occurrence in the water is without significance and not worth noticing. The saline and earthy substances are also too small in quantity to be of any sanitary significance.

"The water from the Ouse at Bedford contains just those calcareous, saline, and organic substances which rain would naturally dissolve from the cultivated soil characteristic of the part of the county through which that river flows. The water is somewhat hard, though only about half the hardness of the water pumped from the subjacent oolitic limestone. The saline substances are of no moment. The organic matter is not in excessive proportion, especially considering that the sample analysed has not been subjected to any process of filtration. On the whole the water compares fairly favourably with other river-waters which, after due filtration, are used for drinking and other purposes by town populations.

"For general manufacturing purposes, for steam raising, and for cleansing operations in which soap is used, the river-water is superior to that raised from the Oolite at the waterworks; for the river-water contains only about half the calcareous and other mineral substances which coat boilers, waste soap with production of curd, and otherwise act prejudicially. Only for ale-brewing would the water from the rock perhaps be better than that from the river.

"For general drinking purposes there is little to choose between the waters. After thorough filtration the river-water would apparently contain the smaller proportion of organic (animal or vegetable) matter; but, on the other hand, the *quality* of the organic matter in the river-water is the more open to suspicion.

"Water from the Lower Greensand could be supplied to Bedford, though at great cost, from a gathering area a dozen miles away. This water would doubtless be far purer (far more free from mineral, vegetable, and animal impurities) than either Oolite water or the river-water."

In a stone-pit and brickyard near the water-works, sections of the Great Oolite limestone, Cornbrash, and Kelloway rock were seen, and here Mr. A. G. C. Cameron gave an account of the geology of the district. The oldest rocks, he said, which come to the surface in Bedfordshire are the Great Oolite limestone and clays seen in this pit. The Cornbrash, locally called "pendle-rock," is here only a foot to eighteen inches thick, and is sometimes merely a band of yellow clay or rubbly stone, but it is very persistent. Above the Cornbrash the Kelloway rock is seen as soft, silty sand, or large cheese-shaped doggers of calcareous sandstone embedded in sand. Then comes the great mass of Oxford Clay, which has suffered much from denudation, having an irregular surface. Here we are at the bottom of it, but in the Ampthill tunnel the top bed of clay occurs 200 feet above this, passing upwards into a bituminous clay, with *Ostrea deltoidea* and other Kimmeridge Clay forms, before finally passing out of sight beneath the picturesquely-wooded heights of the Lower Greensand country bordering on Hertfordshire. Referring then to the superficial

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geology of that portion of the Ouse valley in which Bedford is situated, he said that an immense river must at one time have flowed in the valley of the present Ouse, then at a much higher level, since which it has cut a gap through the soft clays on which it flowed, exposing the underlying harder limestone, and it has filled with a bed of gravel twenty feet thick a valley four miles in breadth. In this valley we find flint-implements, freshwater shells, and the remains of large animals now extinct.

Crossing the great sheet of river-gravel, some limestone-pits were next examined, and on returning to Bedford the members of the two Societies assembled in the Bedfordshire Natural History Society's new room in the General Library, where they were hospitably entertained at lunch by the Mayor.

The rest of the day was occupied in a drive to Elstow, the birthplace of John Bunyan. The church, a Norman structure and one of the few churches in the country with a detached tower, was visited, and in it was seen the pulpit in which Bunyan preached, presumably removed from Mill Lane Chapel, of which he was minister. His cottage also was pointed out in the village, and on the Green the old Moot House was seen.

Field Meeting, 10th July, 1886.

HITCHIN.

This meeting was held in conjunction with the Hitchin Natural History Club and was under the direction of Mr. William Ransom, F.L.S. The party, which numbered about seventy, proceeded from Hitchin to Wilbury Hill, botanising on the way. This hill is supposed to have originally been a British and then a Roman earth-work. Taking advantage of the elevated position, ramparts have been formed by throwing up the earth from within, thus forming an excavation of considerable extent, and from without, forming a ditch or fosse now almost obliterated.

Within the enclosure lunch was served, after which a photograph of the party was taken by a member of the Hitchin Club; and then, from the highest point, commanding an extensive view of the surrounding country, Mr. H. George Fordham, F.G.S., gave an account of the geology of the district.

Wilbury Hill, he said, was just outside the London Basin, which was formed by the Chalk dipping from the north of Herts towards London, where it was covered by thick beds of clay, and rising again south of the Thames. The highest hills seen towards the south were formed of the Upper Chalk capped with boulder-clay, and the ridge of which they were a part was the water-parting or line of division between the area of the London Basin, the streams in which drained into the Thames, and the area in which the streams drained into the Ouse. From this ridge northwards lower and lower beds of the Chalk would be passed over, Wilbury Hill being on the Lower Chalk. To the north of Wilbury Hill the lowest beds of the Chalk, and then the Chalk Marl (with

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the bed of phosphatic nodules, or "coprolite" bed at its base), cropped out, and the low undulating country beyond was formed by the Gault, the outcrop of which was marked by the chimneys of the brick-works at Arlesey. Beyond the Gault the Lower Greensand came to the surface, forming a range of low hills, the beds being well exposed in the railway-cutting at Sandy, and still further north was the plain of the Oxford Clay on which Bedford stands.

Mr. Fordham then referred to the glacial period, at the commencement of which he thought that the general outline of the country was much as it is now, the only subsequent change having been the deepening of the valleys by denudation. While in the London Basin the country was mostly covered by glacial gravels and boulder-clay, to the north patches only capped the higher hills. Large boulders of rocks foreign to the district were found in the clays and gravels, and on the surface of the country where those deposits had been washed away; some of these boulders were of granite, limestone, or millstone-grit from the north of England, showing the direction whence the ice by which they were transported had come.* Wilbury Hill presented difficulties which required further investigation for their solution. The bed of fine chalk rubble and fragmentary chalk flints seen in the bottom of the large pit appeared to have been deposited from running water and to be older than the boulder-clay. If so, it seemed almost necessary to assume that before the glacial period some stream must have stood at that high level, but from the present configuration of the country this appeared improbable, and it would be desirable, before attempting to arrive at a conclusion as to the position of this bed, to ascertain, if possible, how far it extended.

Leaving Wilbury Hill the Icknield Way was followed to Ickleford, and near the ford on the Hiz a photograph of the party was again taken. The church was then visited, and a history of it and of Ickleford was given by Mr. William Ransom. Ickleford, he said, has been a market-town, and there is by the ford a small green surrounded by houses which looks like a place for a market. The name was derived from the situation of the town on the Icknield Way, which passing westward from Baldock crosses the River Hiz by a ford. He well remembered when conveyances travelling from Hitchin to Arlesey had to cross a stream both on entering and leaving Ickleford. The church, dedicated to St. Katherine, was restored under the direction of Sir Gilbert Scott in 1859. The tower, said to be the oldest part, dates back to 1140, and the south doorway, from the character of the Norman enrichments, appears to be of about the same date, though the porch is more recent. Opposite this entrance on the north side is another Norman doorway, now bricked up, indicating that the Vicarage garden, extending along the north side of the church, occupies a portion of the ancient churchyard. Mr. Ransom then described the interior of the church, and remarked that Clutterbuck said that the

* See 'Transactions,' Vol. III, pp. 33 and 47.

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entrance to the nave on the south side was through a handsome Saxon doorway.*

From Ickleford the party returned to Hitchin, visiting Fairfield, the residence of Mr. William Ransom, who provided tea on the lawn, after which his extensive antiquarian collection was inspected, the most interesting portion of which consists of the weapons, pottery, and coins obtained by him in excavations of which he has given an account to the Society.†

Professor Attfield then, as President of the Hertfordshire Natural History Society, proposed a vote of thanks to Mr. Ransom for his kind hospitality and guidance during the day, which was seconded by Dr. Shillitoe, President of the Hitchin Natural History Club, and heartily responded to.

With regard to the entomological results of the meeting Mr. John Hartley Durrant reports that he was enabled to add nine species of Lepidoptera to the known Hitchin fauna, several of these also being new to the county. At Wilbury Hill he captured *Gelechia terella*, *Conchylis subbaumanniana*, *Coccyx nanana*, *Dichrorampha politana*, *Sciaphila nubilana*, and *Catoptria hohenthwarthiana*. In Hitchin he obtained, at the station, *Hecatera dysoidea*; at Bancroft, *Gelechia domestica*; and at Fairfield, *Prays curtisellus*.

The following are the rarer or more interesting plants observed in the course of the day, chiefly in the neighbourhood of Wilbury Hill:—

Papaver Lamottei, Br.
,, *Lecoqii*, Lamotte.
Fumaria Vaillantii, Loisel.
,, *parviflora*, Lam.
Trifolium ochroleucum, Huds.
Lathyrus Nissolia, L.
Œnanthe Lachenalii, C. C. Gmel.
Bulbocastanum Linnæi, Schur.
Galium tricorne, Stokes.
Carduus nutans, L.
Samolus Valerandi, L.
Carex distans, L.
,, *lepidocarpa*, Tausch.
Phleum phalaroides, Koel.

Field Meeting, 6th November, 1886.

THE ALDENHAM WOODS, WATFORD.

This meeting—the fifth annual Fungus Foray—held in Berry Grove Wood and Hearts Spring Wood, near Aldenham, although not numerously attended, was a very successful one in its results, one hundred species of fungi being recorded, including several of considerable rarity, of which one (*Agaricus nigripes*, Pers.) is new to Britain, and another (*Ag. hamadrys*, Fr.) has only recently been added to the British flora, and is known to occur in only one other locality in Britain, having been met with in Kew Gardens the week before for the first time in this country.

Had the foray been held earlier in the year, not nearly so many species would have been seen, for moisture is essential to the growth of these lowly cryptogamic plants, and the dry weather in the autumn has caused them to be very late in appearing this year.

* 'Hist. Herts,' vol. iii, p. 61.
† 'Transactions,' Vol. IV, Part 2, p. 39.

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For the last month, however, rain had fallen about three days out of every four, and this day was the second of two wet ones, on which, together, nearly one inch of rain fell. Had the foray been a few days later, again, there would have been a very different record, owing to the frost of the morning of the 8th, the tender tissues of the fungi not being able to withstand the effect of a few degrees of frost.

In drenching rain and macintoshes, the party, with Mr. Hopkinson as director, and Mr. Massee as mycological referee, walked from Watford by Bushey Mill Bridge to Otterspool, the road traversed, which after leaving the bridge is usually deep in mud except in the dryest weather, being now found to be in many places some inches under water. Berry Grove Wood was entered at the Otterspool end, and at this lower part of it some thirty species of fungi were seen. In the higher part, nearer Aldenham, this number was increased to nearly one hundred, and a few more species were found in Hearts Spring Wood. In the course of the afternoon the rain ceased, but not before the waning light rendered it a difficult matter to detect the fungi amongst the fallen leaves, which some of them so much resemble in colour. In returning to Watford by the Aldenham Road, the 100th species was seen growing in profusion on an old willow stump, where this road in floods is always under water.

The meeting was brought to a close at Wansford House, the residence of the Director, where tea was partaken of by the party, and a few species of fungi, sent by Dr. Brett, of Watford, and Mr. R. T. Andrews, of Hertford, were examined and named.

The following is a list of the species collected, and identified by Mr. George Massee, F.R.M.S. :—

HYMENOMYCETES.

Agaricus (*Amanita*) *muscarius*, L.
,, ,, *vaginatus*, Fr.
,, ,, *mappa*, Batsch.
,, (*Lepiota*) *clypeolarius*, Bull.
,, ,, *cristatus*, Fr.
,, ,, *procerus*, Scop.
,, (*Clitocybe*) *cyathiformis*, Bull.
,, ,, *infundibuliformis*, Sch.
,, ,, *brumalis*, Fr.
,, ,, *phyllophilus*, Fr.
,, ,, *flaccidus*, Sow.
,, ,, *cerussatus*, Fr.
,, (*Collybia*) *rancidus*, Fr.
,, ,, *butyraceus*, Bull.
,, ,, *dryophilus*, Bull.
,, (*Mycena*) *epipterygina*, Scop.
,, ,, *galericulatus*, Scop.
,, ,, *roridus*, Fr.
,, ,, *alcalinus*, Fr.
,, ,, *stylobates*, Fr.
,, ,, *hæmatopus*, Pers.
,, ,, *lacteus*, Fr.
,, ,, *purus*, Pers.
Agaricus (*Mycena*) *galopus*, Schrad.
,, (*Pleurotus*) *salignus*, Fr.
,, (*Pluteus*) *nanus*, Pers.
,, ,, *cervinus*, Sch.
,, (*Entoloma*) *sinuatus*, Fr.
,, (*Molanea*) *nigripes*, Pers.
,, (*Pholiota*) *squarrosus*, Mull.
,, (*Hebeloma*) *crustuliniformis*, Bull.
,, ,, *fastivilis*, Fr.
,, (*Naucoria*) *pediades*, Fr.
,, ,, *hamadryas*, Fr.
,, ,, *melinoides*, Fr.
,, ,, *semiorbicularis*, Bull.
,, (*Galera*) *tener*, Sch.
,, (*Tubaria*) *furfuraceus*, Pers.
,, (*Psalliota*) *campestris*, L.
,, ,, var. *silvicola*.
,, (*Stropharia*) *æruginosus*, Curt.
,, ,, *semiglobatus*, Batsch.
,, (*Hypholoma*) *fasciculare*, Huds.
,, ,, *sublateritius*, Schæff.
,, ,, *velutinus*, Pers.
,, (*Psilocybe*) *spadiceus*, Fr.
,, (*Paneolus*) *campanulatus*, Linn.

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Coprinus comatus, Fr.
,, *atramentarius*, Fr.
Cortinarius (*Dermocybe*) *sanguineus*, Fr.
,, ,, *anomalus*, Fr.
,, (*Myxacium*) *elatior*, Fr.
,, (*Phlegmacium*) *purpurascens*, Fr.
Paxillus involutus, Fr.
Hygrophorus virgineus, Fr.
,, *eburneus*, Fr.
,, *pratensis*, Fr.
Lactarius glyciosmus, Fr.
,, *vellereus*, Fr.
,, *subdulcis*, Fr.
,, *mitissimus*, Fr.
,, *turpis*, Fr.
,, *blennius*, Fr.
Russula nigricans, Fr.
,, *fœtens*, Fr.
,, *adusta*, Fr.
,, *fragilis*, Fr.
,, *emetica*, Fr.
,, *ochroleuca*, Fr.
,, *furcata*, Fr.
,, *rubra*, Fr.
,, *xerampelina*, Fr.
,, *fellea*, Fr.
,, *alutacea*, Fr.
,, *vitellina*, Fr.
Cantharellus cibarius, Fr.
Marasmius ureus, Fr.
,, *ramealis*, Fr.
,, *peronatus*, Fr.
,, *rotula*, Fr.
Nyctalis parasitica, Fr.
Boletus chrysenteron, Fr.
,, *scaber*, Fr.
,, *edulis*, Bull.
,, *piperatus*, Bull.
Polyporus versicolor, Fr.
,, *adustus*, Fr.
Craterellus cornucopioides, Fr.
Stereum hirsutum, Fr.
Corticium sambuci, Pers.
Clavaria rugosa, Bull.
,, *fragilis*, Holms.
,, *cristata*, Holms.
Calocera viscosa, Fr.

GASTROMYCETES.

Lycoperdon pyriforme, Sch.
,, *gemmatum*, Batsch.
,, *cœlatum*, Fr.

ASCOMYCETES.

Helotium tuba, Fr.
Rhytisma acerinum, Fr.
Hypoxylon multiforme, Fr.
Xylaria hypoxylon, Grev.

ORDINARY MEETING, 16TH NOVEMBER, 1886, AT WATFORD.

Professor ATTFIELD, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

Mr. J. E. K. Cutts was elected a Member of the Society.

Mr. Arthur M. Brown, B.A., Beech Grove, Tring; Mr. W. R. Carter, 4 Derby Road, Watford; and Mr. William Coles, 60 Queen's Road, Watford, were proposed as Members.

The following lecture was delivered:—

"The Flora of the British Possessions." By J. Gilbert Baker, F.R.S., F.L.S.

ORDINARY MEETING, 2ND DECEMBER, 1886, AT HERTFORD.

AUGUSTUS HAWKS, Esq., in the Chair.

Mr. Perceval Bosanquet, Ponfield, Little Berkhamsted, was proposed as a Member of the Society.

The following paper was read:—

"The Habits and Economy of our Social Wasps." By F. M. Campbell, F.L.S., F.Z.S., F.R.M.S. (*Transactions*, Vol. IV, p. 153.)

ORDINARY MEETING, 21ST DECEMBER, 1886, AT WATFORD.

Professor ATTFIELD, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

Mr. Arthur M. Brown, B.A., Mr. W. R. Carter, and Mr. William Coles were elected Members of the Society.

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Mr. Harold Proctor, Hunton Bridge, Watford, and Mr. W. Hammond Solly, M.A., F.G.S., Serge Hill, Abbot's Langley, were proposed as Members.

The following paper was read:—

"The Germ Theory of Disease." By C. E. Shelly, B.A., M.B., Hon. Sec.

ORDINARY MEETING, 18TH JANUARY, 1887, AT WATFORD.

Professor ATTFIELD, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

Mr. Perceval Bosanquet, Mr. Harold Proctor, and Mr. W. Hammond Solly, M.A., F.G.S., were elected Members of the Society.

The following lecture was delivered:—

"On Fish and Fish-culture." By W. Oldham Chambers, F.L S., Secretary and Director of the National Fish-culture Association.

Mr. Upfield Green and Mr. John Weall were appointed Auditors of the accounts for 1886.

ANNIVERSARY MEETING, 15TH FEBRUARY, 1887.

(AT WATFORD.)

Professor ATTFIELD, Ph.D., F.R.S., F.I.C., F.C.S., President, in the Chair.

The Report of the Council for 1886, and the Treasurer's Account of Income and Expenditure, were read and adopted.

The President delivered an Address on "The Laws of Nature in relation to Health." (*Transactions*, Vol. IV, p. 129.)

The following gentlemen were duly elected as the Officers and Council for the ensuing year:—

President.—F. M. Campbell, F.L.S., F.Z.S., F.R.M.S., F.E.S.

Vice-Presidents.—Prof. John Attfield, Ph.D., F.R.S., F.I.C., F.C.S.; Perceval Bosanquet; Richard B. Croft, R.N., F.L.S., F.R.M.S.; John Evans, D.C.L., LL.D., F.R.S., Pres.S.A., F.L.S., F.G.S., etc.; Augustus Hawks; John Hopkinson, F.L.S., F.G.S., F.R.M.S., F.R.Met.Soc.

Treasurer.—Charles R. Humbert.

Honorary Secretaries.—Frederick G. Lloyd, and C. E. Shelly, B.A., M.B.

Librarian.—F. Haycraft Berry, M.D.

Curator.—William Verini.

Other Members.—Allan Barraud; A. P. Blathwayt; Alfred T. Brett, M.D.; Alfred Fowell Buxton; Arthur E. Gibbs, F.L.S.; Upfield Green; Daniel Hill; T. Mark Hovell, F.R.C.S.; John Morison, M.D., F.G.S.; Isaac Robinson; George Rooper, F.Z.S.; Arthur Stradling, C.M.Z.S.

The thanks of the Society were accorded to Professor Attfield, Ph.D., F.R.S., etc., retiring from the office of President; to Dr. A. T. Brett, Mr. F. M. Campbell, F.L.S., etc., and the Right Hon.

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the Earl Cowper, K.G., retiring from the office of Vice-President; and to Mr. John E. Littleboy, Mr. F. W. Phillips, F.L.S., and Mr. F. W. Silvester, F.R.Met.Soc., retiring from the Council.

Report of the Council for 1886.

In presenting the Twelfth Annual Report, the Council of the Hertfordshire Natural History Society and Field Club is able to state that the Society maintains its prosperous and vigorous condition, the total number of meetings held during 1886 being greater than in any previous year. The attendances, particularly at the evening meetings, have somewhat fallen off, but the Council hopes that the members will endeavour to maintain the position the Society holds, and show their interest in the work being done, by attending as many meetings as possible.

During the year twelve ordinary members and one honorary member have been elected, fifteen members have resigned, and the Council regrets to have to record the loss of four members (two life members and two annual subscribers) by death. The census of the Society at the end of the years 1885 and 1886 was:—

	1885.	1886.
Honorary Members	19	20
Life Members	44	42
Annual Subscribers	202	197
	265	259

The following papers and lectures have been read or delivered during the year:—

Jan. 26, at Watford.—On a Diagram for a Model of the Solar System to scale; by Arthur Cottam, F.R.A.S.

Feb. 2, at Watford.—Plants and their Uses; by John R. Jackson, A.L.S.

—— 16, at Watford.—Anniversary Address; by the President, Professor Attfield, Ph.D., F.R.S., F.I.C., F.C.S.

—— 25, at Hertford.—The Germ Theory of Disease; by C. E. Shelly, B.A., M.B., Hon. Sec.

March 16, at Watford.—Wild Plants: their Attributes and Names; by F. G. Lloyd, Hon. Sec.

—— 18, at Hertford.—An Account of British and Roman Remains found in the Neighbourhood of Hertford; by William Ransom, F.L.S.

April 20, at Watford.—Report on Insects observed in Hertfordshire during the year 1885; by F. W. Silvester, F.R.Met.Soc.

—— Notes on Birds observed in Hertfordshire during the year 1885; by John E. Littleboy.

—— 29, at Hertford.—Meteorological Observations taken at Throcking, Herts, during the year 1885; by the Rev. C. W. Harvey, M.A., F.R.Met.Soc.

—— Report on the Rainfall in Hertfordshire in 1885; by the Rev. C. W. Harvey.

—— On a Model of the Solar System; by Arthur Cottam, F.R.A.S.

May 11, at Watford.—Meteorological Observations taken at Wansford House, Watford, during the year 1885; by John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

—— Report on Phenological Phenomena observed in Hertfordshire during the year 1885; by John Hopkinson.

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Nov. 16, at Watford.—The Flora of the British Possessions; by J. Gilbert Baker, F.R.S., F.L.S.
Dec. 2, at Hertford.—The Habits and Economy of our Social Wasps; by F. M. Campbell, F.L.S., F.Z.S., F.E.S.
—— 21, at Watford.—The Germ Theory; by C. E. Shelly, B.A., M.B.

Of these papers and lectures it will be seen that all but two were by members of the Society, and the Council will be glad of offers of papers from members for the next session, as also to hear from any member who will undertake to conduct a field meeting or to assist therein.

The following Field Meetings were held during the year:—

May 8.—St. Albans.
—— 15.—Welwyn.
—— 20.—Hatfield.
June 5.—St. Albans.
—— 10.—Broxbourne.
—— 12.—Watford.
June 26.—Pinner.
July 1.—Broxbourne.
—— 3.—King's Langley.
—— 8.—Bedford.
—— 10.—Hitchin.
Nov. 6.—Watford.

Six of these meetings were held in conjunction with other Societies,—those of May 15th and June 26th with the Geologists' Association, that of June 5th with the St. Albans Archæological Society, June 19th with the Quekett Microscopical Club, July 8th with the Bedfordshire Natural History Society, and July 10th with the Hitchin Natural History Club.

The meeting on Nov. 6th was a Fungus Foray, on which occasion Mr. George Massee kindly gave his services, accompanying the members, who succeeded in finding one species of fungus new to Britain, and another that had only been met with once before.

The Society is indebted, for hospitality kindly afforded at the field meetings, to Mr. S. Monckton White and Mr. I. N. Edwards at St. Albans, to Canon Wingfield at Welwyn, to Mr. S. T. Holland and the President at Watford, and to Dr. Brett after the Pinner meeting, to Mr. Manser at Hoddesdon, to Mr. Littleboy at King's Langley, to the Mayor of Bedford, Mr. Edwin Ransom, at Bedford, and to Mr. W. Ransom and the Hitchin Natural History Club at Hitchin.

The third volume of the present series of the Society's 'Transactions' has been completed and the fourth volume has been commenced, two parts of the former and three of the latter, containing 148 pages and 5 plates, having been published during the year. In this third volume the papers relating to the Natural History of the county cover a wide area. In Meteorology there are the usual annual reports; in Geology there are papers on our boulders and boulder-clay, detailed accounts of well-sections, and a list of works on the Geology of Hertfordshire; in Botany there are papers on our diatoms and mosses and a list of the rarer flowering plants observed; and in Zoology the Protozoa, Mollusca, and Lepidoptera are treated of, and there are the usual reports on the insects and birds observed. In addition to these local papers the volume contains important memoirs on the "Origin and Constitution of Chalk and Flint," on "Instinct," and on the "Nests and Eggs of Birds," and also the Anniversary Addresses delivered in 1884 and 1885.

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The thanks of the Society are due to Mr. H. G. Fordham, F.G.S., for the map and sections illustrating the distribution of the boulder-clay of North Herts; to Mr. F. W. Phillips, F.L.S., for the lithograph of the Discostomatous Protozoa of Hertfordshire; and to Dr. John Evans, F.R.S., for the plate and woodcuts illustrating the evolution of types on ancient British coins.

The late Mr. A. R. Pryor's 'Flora of Hertfordshire' is now approaching completion. Twenty-five sheets (400 pages) are printed, bringing the work down to the Monocotyledons, and a few more sheets now in type and under revision will complete the flowering plants. The work will probably extend to about 600 pages, considerably more than was at first anticipated. In addition to the 500 ordinary copies, 50 large paper copies are being printed on hand-made paper.

The library is in a satisfactory condition, and numerous books have been received by donation and exchange during the past year. The use of the books by members not having increased, as was expected would have been the result of the publication of the Catalogue, the Council hopes shortly to issue new regulations which will facilitate the borrowing of books. A few microscopic and other objects of local interest have been presented to the Society, and further donations will be acceptable.

In conclusion the Council has to express the thanks of the Society to the Committee of the Watford Public Library for the accommodation afforded for your library and the Watford meetings.

Additions to the Library in 1886.

Presented.

Title.	Donor.
Attfield, Prof. J. The Laws of God in Nature. (*Trans. Herts Nat. Hist. Soc.* 1886.)	*The Author.*
Badcock, J. Vignettes from Invisible Life. 8vo. London, 1883.	,,
Conchology, Journal of. Vol. i, No. 1. 8vo. London, 1874.	*Mr. J. Hopkinson.*
Cooke, M. C. (Ed.) Grevillea. Vol. xv, Nos. 71–74. 8vo. London, 1886.	*The Editor.*
Culpeper, N. The Complete Herbal ..... English Physician enlarged and Key to Physic. 4to. London, 1843.	*Mr. D. Hill.*
Dalton, W. H. Note on the range of the Lower Tertiaries of East Suffolk. (*Rep. Brit. Assoc.* 1880.)	*Mr. W. Whitaker.*
Evans, Dr. J. Royal Society. Address of the Treasurer delivered at the Anniversary Meeting, 1884. 8vo. London, 1884.	*The Author.*
——. Address to the Society of Antiquaries. Anniversary, ... 1886. 8vo. London, 1886.	,,
Ewart, Dr. J. A few words upon (1) the Lowest Forms of Living Things, (2) Physiology, (3) the Aryan and Aboriginal Races of India. (*Brighton and Sussex Nat. Hist. Soc.* 1884.)	,,
——. Forestry in India. (*Ib.* 1885.)	,,
——. Louis Pasteur: his Life and Labours. (*Ib.* 1886.)	,,

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INCOME AND EXPENDITURE FOR THE YEAR ENDING 31st DECEMBER, 1886.

Dr.	£	s.	d.
To Balance from 1885	47	15	10
,, Entrance Fees	5	0	0
,, Subscriptions for 1884	0	10	0
,, ,, ,, 1885	6	0	6
,, ,, ,, 1886	59	12	0
,, ,, ,, 1887	12	11	6
,, Dividend on £203 4s. 6d. Consols (less Income Tax)	5	17	10
,, Deposit withdrawn from London and County Bank	100	0	0
,, Interest on deposit	1	13	1
	£239	0	9

Cr.	£	s.	d.
By Printing 'Transactions'	74	0	2
,, ,, Library Catalogue	18	10	6
,, Miscellaneous Printing	8	5	9
,, Expenses of Meetings	10	4	5
,, Library	4	19	0
,, Salary of Assistant	6	0	0
,, Postages	18	1	6
,, Sundry small expenses	1	5	0
,, Expenditure on the 'Flora of Hertfordshire'	56	17	9
,, Balance at Bank	40	16	8
	£239	0	9

Amount invested in the purchase of £203 4s. 6d. Consols .... £198 15s.

Audited and found correct, this 14th day of February, 1887, { UPFIELD GREEN, JOHN WEALL.

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Title.	Donor.
French, H. H. On Bournes. (*Sutton Scientific Society*, 1883.)	*The Author.*
Hudleston, W. H. The Geology of Malton and Neighbourhood. (*Malton Field Nat. Soc.* 1884.)	,,
Jones, Prof. T. R., and W. Whitaker. Addresses on the Chalk, Sands, and Clays at Shaw Hill near Newbury. (*Trans. Newbury-District Field-Club*, 1878.)	*Mr. W. Whitaker.*
Linnean Society. Journal. Botany. Vols. xix–xxi, Nos. 120–136. Zoology. Vols. xvi–xviii, Nos. 93–107.	*Mr. R. B. Croft.*
Ormerod, Miss E. A. The Hessian Fly (*Cecidomya destructor*) in Great Britain . . . . 12mo. London, 1886.	*The Authoress.*
——. Report of Observations of Injurious Insects and Common Farm Pests during the year 1885 . . . . 8vo. London, 1886.	,,
Preston, Rev. T. A. Report on the Phenological Observations for the year 1885. (*Quart. Journ. Met. Soc.* 1886.)	*The Author.*
Pryor, R. A. On the Botanical Work of the past Season [with Autograph letter and MS. notes]. (*Trans. Watford Nat. Hist. Soc.* 1876.)	*Mr. J. Hopkinson.*
Symons, G. J. (Ed.) Monthly Meteorological Magazine. Vol. xxi. 8vo. London, 1886.	*The Editor.*
Whitaker, W. List of Works on the Geology of Cambridgeshire. 8vo. Cambridge, 1873.	*The Author.*
——. List of Works on the Geology, etc., of Cornwall, (*Journ. R. Inst. Cornwall*, 1875.)	,,
——. List of Works on the Geology, Mineralogy, and Palæontology of Cheshire. (*Proc. Liverpool Geol. Soc.* 1876.)	,,
——. Note on the Red Crag. (*Quart. Journ. Geol. Soc.* 1877.)	,,
——. List of Works on the Geology, Mineralogy, and Palæontology of Wales. (*Rep. Brit. Assoc.* 1880.)	,,
——. Well-section at Stonehouse, Plymouth. (*Devon. Assoc. Adv. Sci.* 1881.)	,,
——. List of Works relating to the Geology of Cumberland and Westmoreland. (*Trans. Cumberland Assoc.* 1882.)	,,
——. On Things in General, and the Red Chalk of Norfolk in particular. (*Proc. Norwich Geol. Soc.* 1883.)	,,
——. On the probable occurrence of Totternhoe Stone near Roydon, Norfolk. (*Ib.* 1884.)	,,
——. Note on a Deep Well at the Carrow Works, Norwich . . . . (*Ib.* 1884.)	,,
——. The Work of the Year as regards Norfolk. . . . . (*Ib.* 1884.)	,,
——. List of Works on the Geology, Mineralogy, and Palæontology of Staffordshire, Worcestershire, and Warwickshire. (*Rep. Brit. Assoc.* 1885.)	,,
——. Chronological List of Works on the Coast-Changes and Shore-Deposits of England and Wales. (*Ib.* 1885.)	,,
——. On "A Recent Legal Decision in connection with Water Supply from Wells." (*Trans. Sanitary Inst.* 1885.)	,,
——. On some Borings in Kent. A contribution to the deep-seated Geology of the London Basin. (*Quart. Journ. Geol. Soc.* 1886.)	,,
——. Some Surrey Wells and their Teachings. (*Trans. Croydon Nat. Hist. Club*, 1886.)	,,

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TITLE.	DONOR.
WOODWARD, A. Foraminifera from Bermuda. (*Journ. New York Micros. Soc.* 1885.)	*The Author.*
——, and B. W. THOMAS. On the Foraminifera of the Boulder-Clay . . . . near Litchfield, Meeker County, Minnesota. (*Rep. Geol. Surv. Minnesota*, 1885.) .	*The Authors.*
ZOOLOGICAL SOCIETY. Transactions. Vol. xi, part 11, vol. xii, part 1. 4to. London, 1885–86. . . .	*Mr. A. Stradling.*

RECEIVED IN EXCHANGE.

BATH NATURAL HISTORY AND ANTIQUARIAN FIELD CLUB. Proceedings. Vol. vi, No. 1. 8vo. Bath, 1886.

BELFAST NATURAL HISTORY AND PHILOSOPHICAL SOCIETY. Report and Proceedings for 1885–86. 8vo. Belfast, 1886.

BELFAST NATURALISTS' FIELD CLUB. Annual Report and Proceedings. Series 2, vol. ii, parts 4 and 5. 8vo. Belfast, 1885–86.

BIRMINGHAM NATURAL HISTORY AND MICROSCOPICAL SOCIETY. Annual Report for 1885. 8vo. Birmingham, 1886.

BIRMINGHAM PHILOSOPHICAL SOCIETY. Proceedings. Vol. v, part 1. 8vo. Birmingham, 1886.

BOSTON SOCIETY OF NATURAL HISTORY. Proceedings. Vol. xxii, part 4, vol. xxiii, part 1. 8vo. Boston (U.S.A.), 1885.

BRIGHTON AND SUSSEX NATURAL HISTORY SOCIETY. Annual Reports for 1884 and 1885. 8vo. Brighton, 1885–86.

CARDIFF NATURALISTS' SOCIETY. Report and Transactions for 1885. Vol. xvii. 8vo. Cardiff, 1886.

CHESTER SOCIETY OF NATURAL SCIENCE. Annual Report for 1885–86. 8vo. Chester, 1886.

CONCHOLOGY, JOURNAL OF. Vol. v, Nos. 1–4. 8vo. London and Leeds, 1886.

CUMBERLAND AND WESTMORELAND ASSOCIATION. Transactions. No. 11. 8vo. Carlisle, 1886.

EDINBURGH. BOTANICAL SOCIETY. Transactions and Proceedings. Vol. xv, part 2, vol. xvi, part 2. 8vo. Edinburgh, 1884–86.

EDINBURGH. ROYAL PHYSICAL SOCIETY. Proceedings, Sessions 1884–85, 1885–86. 8vo. Edinburgh, 1885–86.

FORESTRY. Vol. xi, Nos. 15–18. 8vo. Edinburgh, 1886.

GLASGOW, GEOLOGICAL SOCIETY OF. Transactions. Vol. vii, part 1. 8vo. Glasgow, 1886.

GLASGOW NATURAL HISTORY SOCIETY. Proceedings. New Series, vol. i, part 2. 8vo. Glasgow, 1886.

————. Index to Proceedings, vols. i–v. *Ib.* 1886.

GLASGOW, PHILOSOPHICAL SOCIETY OF. Proceedings. Vol. xvii. 8vo. Glasgow, 1886.

HEMEL HEMPSTEAD NATURAL HISTORY SOCIETY. Annual Report for 1885. 8vo. Hemel Hempstead, 1886.

LIVERPOOL GEOLOGICAL SOCIETY. Proceedings. Vol. v, part 2. 8vo. Liverpool, 1886.

LIVERPOOL LITERARY AND PHILOSOPHICAL SOCIETY. Proceedings, 1884–85. Vol. xxxix. 8vo. Liverpool, 1885.

LIVERPOOL NATURALISTS' FIELD CLUB. Proceedings for 1885–86. 8vo. Liverpool, 1886.

LIVERPOOL SCIENTIFIC STUDENTS' ASSOCIATION. Annual Report for 1885–86. 8vo. Liverpool, 1886.

LONDON. ENTOMOLOGICAL SOCIETY. Proceedings for 1885. 8vo. London, 1886.

LONDON, GEOLOGICAL SOCIETY OF. Abstracts of the Proceedings, Session 1885–86. 8vo. London, 1886.

LONDON. GEOLOGISTS' ASSOCIATION. Proceedings. Vol. ix, Nos. 4–7. 8vo. London, 1885–86.

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LONDON. QUEKETT MICROSCOPICAL CLUB. Journal. Second Series, vol. ii, Nos. 14–16. 8vo. London, 1886.
LONDON. ROYAL AGRICULTURAL SOCIETY. Journal. Vol. xix, part 1, vol. xx, parts 1, 2, vol. xxi, part 1. 8vo. London, 1883–85.
LONDON. ROYAL METEOROLOGICAL SOCIETY. Quarterly Journal. Vol. xi, No. 56, vol. xii, Nos. 57–59. 8vo. London, 1885–86.
———. ———. THE METEOROLOGICAL RECORD. Vol. v, Nos. 18–20, vol. vi, Nos. 21, 22. *Ib.* 1885–86.
LONDON. ROYAL MICROSCOPICAL SOCIETY. Journal. Ser. 2, vol. vi, Nos. 50–54. 8vo. London, 1886.
MANCHESTER FIELD NATURALISTS' AND ARCHÆOLOGISTS' SOCIETY. Report and Proceedings for 1885. 8vo. Manchester, 1886.
MANCHESTER GEOLOGICAL SOCIETY. Transactions. Vol. xviii, parts 11–20, vol. xix, part 1. 8vo. Manchester, 1885–86.
MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY. Proceedings. Vols. xxiii, xxiv. 8vo. Manchester, 1884–85.
——— MEMOIRS. Series III, vol. viii. 8vo. London, 1885.
MANCHESTER SCIENTIFIC STUDENTS' ASSOCIATION. Report and Proceedings for 1885. 8vo. Manchester, 1886.
MARLBOROUGH COLLEGE NATURAL HISTORY SOCIETY. Report for 1885. 8vo. Marlborough, 1886.
MIDLAND NATURALIST. Vol. ix. 8vo. Birmingham, 1886.
NATURALIST. New Series. Vol. xi. 8vo. Leeds, 1886.
NEW YORK ACADEMY OF SCIENCES. Annals. Vol. iii, Nos. 7–10. Transactions. Vol. iii. 8vo. New York, 1885–86.
NEW YORK MICROSCOPICAL SOCIETY. Journal. Vol. i, Nos. 8, 9, vol. ii, Nos. 1–5. 8vo. New York, 1885–86.
NORTHAMPTONSHIRE NATURAL HISTORY SOCIETY. Journal. Nos. 24–27. 8vo. Northampton, 1886.
RUGBY SCHOOL NATURAL HISTORY SOCIETY. Report for 1885. 8vo. Rugby, 1886.
SCIENCE GOSSIP. Vol. xxii. 8vo. London, 1886.
SIDCUP LITERARY AND SCIENTIFIC SOCIETY. Annual Report for 1884–85. 8vo. Sidcup, 1886.
SMITHSONIAN INSTITUTION. Annual Reports for 1883 and 1884. 8vo. Washington (U.S.A.), 1884–85.
UNITED STATES GEOLOGICAL SURVEY. Fourth and Fifth Annual Reports, 1882-83, 1883-84. By W. POWELL. 4to. Washington, 1884–85.
———. Bulletin. Nos. 7-12, 14-26. 8vo. Washington, 1884–85.
———. Monographs. Vol. ix. Brachiopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of New Jersey. By R. P. Whitfield. 4to. Washington, 1885.
WILTSHIRE ARCHÆOLOGICAL AND NATURAL HISTORY SOCIETY. Magazine. Vol. xxii, No. 66, vol. xxiii, No. 67. 8vo. Devizes, 1886.
YORKSHIRE GEOLOGICAL AND POLYTECHNIC SOCIETY. Proceedings. Vol. ix, part 1. 8vo. Leeds, 1885.

PURCHASED.

BOTANY, Journal of. New Series, vol. xv. 8vo. London, 1886.
BUCKLER, W. The Larvæ of the British Butterflies and Moths. Vol. i. (*Ray Society.*) 8vo. London, 1886.
ENTOMOLOGIST. Vol. xix. 8vo. London, 1886.
MELDOLA, R., and W. WHITE. Report on the East Anglian Earthquake of April 22nd, 1884. 8vo. London, 1886.
YEAR-BOOK of the Scientific and Learned Societies of Great Britain and Ireland. Third Annual Issue. 8vo. London, 1886.
ZOOLOGIST. 3rd Series, vol. x. 8vo. London, 1886.

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ORDINARY MEETING, 24TH FEBRUARY, 1887, AT HERTFORD.

HENRY GILBERTSON, Esq., in the Chair.

Mr. Henry S. Allen, 42, High Street, Watford; Mr. R. André, Melrose, Bushey Grove, Watford; Mr. J. B. Scott, F.R.G.S., Hillhead, Broxbourne; and Mrs. John Taylor, Hayes, St. Albans Road, Watford, were proposed as Members of the Society.

The following paper was read:—

"Observations on Diatomaceæ from the Neighbourhood of Hertford." By Isaac Robinson. (*Transactions*, Vol. IV, p. 196.)

Diagrams, models, and microscopic specimens were exhibited by Mr. Robinson in illustration of his paper.

ORDINARY MEETING, 22ND MARCH, 1887, AT WATFORD.

ALFRED T. BRETT, Esq., M.D., in the Chair.

Mr. Henry S. Allen, Mr. R. André, Mr. J. B. Scott, F.R.G.S., and Mrs. John Taylor were elected Members of the Society.

Mr. Arthur R. Nicols, F.G.S., F.R.G.S., 3, Denmark Street, Watford; Mr. T. V. Roberts, Verulam House, Watford; and Mr. W. Weston, Grove Mill, Watford, were proposed as Members.

The following paper was read:—

"Notes on Birds observed in Hertfordshire during the year 1886." By John E. Littleboy. (*Transactions*, Vol. IV, p. 161.)

ORDINARY MEETING, 31ST MARCH, 1887, AT HERTFORD.

F. M. CAMPBELL, Esq., F.L.S., F.R.M.S., F.E.S., President, in the Chair.

The following paper was read:—

"On some points in the Anatomy of the Honey-Bee." By R. T. Andrews.

Microscopic specimens and diagrams were exhibited by Mr. Andrews in illustration of his paper.

FIELD MEETING, 16TH APRIL, 1887.

SPRINGFIELD, ST ALBANS.

Meeting at the Horseshoes village about half-way between St. Albans and Hatfield, the members, about forty in number, under the direction of Mr. S. Monckton White, walked by Pope's Field Farmhouse across the fields to Beech Cottage, where the Director read some notes on the neighbourhood with special reference to the rearing of partridges and pheasants.

There are here, Mr. White said, two farms adjoining each other, one, the "Beech," so named from the beech trees which flourish in the neighbourhood, and the other, the "Great Nast Hyde," deriving part of its name from a "hide" of land, which was about 120 acres; but from what the word "Nast" was derived he had been unable to determine. These farms comprise arable land, pasture, and woodland, the woods being named Tanner's, the Home, and Ball's Cover. In the Home Wood was a pond in

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which dace and perch abound, and from which a carp over three pounds in weight had been landed; while moorhens were sometimes seen on the water, and in severe weather it had been frequented by wild ducks. On these farms, partridges, he said, were plentiful. In the mornings they repair to the stubble, grass fields, and hedge-sides, which they leave for the shelter of clover, turnip, and potato fields during mid-day, returning again towards evening to their feeding-grounds. At night they generally lodge in the middle of a field for security, lying in a cluster with their heads outwards. Like many other birds, and to an especial degree, they use devices, such as feigning to be dead, to entice supposed enemies away from their nest. They are supposed to pair for life. They are strong and quick in flight, gradually rising to a little height and then flying off in a direct course with a loud "whirr," the effect of the rapid pulsation of their wings. The green fields adjacent to the woods, Mr. White continued, are peculiarly adapted to the breeding of pheasants. Eggs being supplied from pheasantries about the 1st of May, fowls anxious to sit are procured, each is placed on from sixteen to twenty eggs, and in from twenty-four to twenty-six days the eggs cracked and the little pheasants began to creep through. When two days old they and their foster-parents are removed to a coop on a sunny meadow and fed six times a day on oatmeal, rice, eggs, etc., and as the birds grow they gradually leave the hens and wander into the nearest wood, where they are supplied with maize and wheat. As soon as the eggs are laid the male pheasant deserts the hen, and she alone has the rearing of the young.

On the conclusion of Mr. White's remarks, of which the above is only a brief summary, the Home Wood was explored, the pond in it affording specimens to the microscopists, and the botanists finding in flower large patches of the daffodil, and the adoxa, wood-anemone, ground-ivy, and other plants.

In a tent erected near Beech Cottage, tea was then provided by Mr. White, to whom a vote of thanks was accorded on the proposition of Mr. Hopkinson, seconded by Dr. Morison.

The following species of Mosses were found in the Home Wood by Mr. A. E. Gibbs, F.L.S.:—

ACROCARPI.

Dicranella heteromalla, Hedw.
Barbula muralis, L.
Ceratodon purpureus, L.
Orthotrichum Lyellii, H. & T.
Mnium punctatum, Hedw.
Atrichum undulatum, L.

AMPHOCARPI.

Fissidens bryoides, Hedw.

PLEUROCARPI.

Neckera complanata, L.
Thuidium tamariscinum, Hedw.
Thamnium alopecurum, L.
Homalothecium sericeum, L.
Brachythecium rutabulum, L.
Eurhynchium striatum, Schreb.
" *piliferum*, Schreb.
" *prælongum*, Dill.
Rhynchostegium confertum, Dicks.
Amblystegia serpens, L.
" *riparium*, L.
Hypnum cupressiforme, L.
" " var. *filiforme*, Bry. Eur.
" *cuspidatum*, L.
" *purum*, L.
Hylocomium squarrosum, L.
" *triquetrum*, L.

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ORDINARY MEETING, 19TH APRIL, 1887, AT WATFORD.

F. M. CAMPBELL, Esq., F.L.S., F.Z.S., F.R.M.S., F.E.S., President, in the Chair.

Mr. Arthur R. Nicols, F.G.S., F.R.G.S., Mr. T. V. Roberts, and Mr. W. Weston, were elected Members of the Society.

Mr. and Mrs. Howard Braden, Malden Cottage, Clarendon Road, Watford, and Mr. H. A. Vincent, 11, Gladstone Road, Watford, were proposed as Members.

The following papers were read:—

1. "Meteorological Observations taken at Wansford House, Watford, during the year 1886." By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc. (*Transactions*, Vol. IV, p. 169.)

2. "Report on Phenological Phenomena observed in Hertfordshire during the year 1886." By John Hopkinson. (*Transactions*, Vol. IV, p. 176.)

3. "A Naturalist's Calendar for the Northern Border of Hertfordshire." By H. George Fordham, F.G.S. (*Transactions*, Vol. IV, p. 193.)

4. "List of Flowering Plants observed in Hertfordshire during the year 1886." By Ada Selby.*

5. "Report on Insects observed in Hertfordshire during the year 1886." By F. W. Silvester, F.R.Met.Soc. (*Transactions*, Vol. IV, p. 201.)

6. "On Fog-bows at Odsey." By H. George Fordham, F.G.S. (*Transactions*, Vol. IV, p. 221.)

7. "Note on a Nectarine growing on a Peach Tree." By Alfred T. Brett, M.D. (*Transactions*, Vol. IV, p. 222.)

8. "A Biography of a Cuckoo." By John E. Littleboy. (*Transactions*, Vol. IV, p. 223.)

9. "Note on Dogs entrapped while following Rabbits." By the Right Honourable the Lord Ebury, F.R.G.S., F.R.Met.Soc. (*Transactions*, Vol. IV, p. 223.)

10. "Miscellaneous Notes." By Alfred T. Brett, M.D.

ORDINARY MEETING, 9TH MAY, 1887, AT ST. ALBANS.

JOHN HOPKINSON, Esq., F.L.S., F.G.S., etc., Vice-President, in the Chair.

The following lecture was delivered:—

"Earthquakes and their Relation to Volcanic Phenomena." By F. W. Rudler, F.G.S., Hon. Sec. A.I., Pres. Geol. Assoc., Curator of the Museum of Practical Geology.

Maps and diagrams were exhibited by Mr. Rudler in illustration of his lecture.

* To be incorporated with the list for 1887.

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Field Meeting, 14th May, 1887.

WATFORD AND BUSHEY.

The object of this meeting was to examine sections of the Chalk and overlying Eocene beds in the neighbourhood of Bushey under the direction of Dr. John Morison, F.G.S.

The chalk-pit near Bushey Station was first visited, Dr. Morison drawing attention to the lines of flints which indicate the Upper Chalk, and to the cavities called "pockets" or "pipes" filled with clay and pebbles from the Eocene beds above, which have taken the place of the chalk dissolved away. He was about to give an explanation of this process, which has frequently been alluded to in the Society's 'Transactions,' when a workman in charge of the pit interposed, objecting to the intrusion of the visitors, apparently oblivious of the fact that geologists consider they have a perfect right to invade any one's property in pursuit of their study, but he was eventually appeased by the purchase of a few fossils he had obtained from the Chalk.

The Bushey brickfield was then visited, Dr. Morison stating that it showed a good section of the Lower Eocene beds. Above was the London Clay of a dark chocolate-brown colour, and of great tenacity; below this was the basement-bed of sandy clay with dark flint-pebbles, and peculiar fossils; and under this again were the Woolwich and Reading Beds, consisting here of mottled clays and gravels almost unfossiliferous, though elsewhere they yielded fossils which in some places were marine, in others estuarine, and in others freshwater, showing great alternations of conditions during the deposition of the beds.

Crossing the fields towards Watford Heath, a pit in the London Clay was inspected, and then a brickfield by the side of Oxhey Lane, where the Reading Beds are again exposed, and show a marked difference from the same beds as seen at Bushey for such a short distance between them.

A pleasant walk again across the fields brought the party to Haydon Hill, where Mr. and Mrs. Attenborough most kindly provided tea, and, after the conservatory and grounds had been visited, a field-path was taken to Bushey Station and Watford.

Ordinary Meeting, 24th May, 1887, at Hertford.

Edward Manser, Esq., in the Chair.

The following paper was read:—

"The Hessian Fly." By F. M. Campbell, F.L.S., F.Z.S., F.R.M.S., F.E.S., President. (*Transactions*, Vol. IV, p. 180.)

Puparia of the Hessian Fly, affected straw, and diagrams were exhibited by the President in illustration of his paper.

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Field Meeting, 4th June, 1887.

RICKMANSWORTH.

Sections exposed in making the new line of railway from Pinner to Rickmansworth were examined by the Society in June, 1886.* The London Clay and Woolwich and Reading Beds were then seen, and the line was left near Moor Park before it crosses the valley of the Colne. On the opposite side of this valley the Chalk has been cut into, and this meeting was originally arranged to enable the members to examine sections of the Upper Chalk thus exposed. It was found, however, towards the end of May, that the cuttings in the Chalk were no sooner completed than they were covered up with a layer of soil on which grass was destined soon to grow, and the programme had to be altered. Although the route now chosen was not, perhaps, so interesting geologically as that which had to be abandoned might have been, it had the advantage of being more picturesque.

The meeting, as last year, was held in conjunction with the Geologists' Association, and was under the direction of Mr. Hopkinson. From Rickmansworth (London and North-Western) Station† the members of the two Societies crossed the fields to Woodcock Hill Kiln, halting on the way on the summit of a hill, 260 feet above sea-level, from which was obtained a view of the valley of the Colne, and of the junction with it of the subsidiary valleys of the Chess and Gade.

This hill, the Director stated, owes its existence to the bed of gravel seen upon it. The top, as usual with hills of chalk (as well as hills of clay) capped with gravel, is flat, and there is a steep slope towards the valley of the Colne and a gentler slope in other directions. This conformation is due to the preservation from subaërial denudation of the gravel-covered portion of the hill, the rain falling upon it percolating through the gravel without washing it away to any considerable extent, whereas outside the margin of the gravel the rain washes away the chalk, or, by the carbonic acid it contains, chemically dissolves it, and this more rapidly towards the valley than towards the higher ground behind the hill; the steep slope being formed by the resistance to denudation of the edge of the bed of gravel, which, however, would gradually give way by the undermining of the chalk. Towards the west another similar gravel-capped hill was seen, the steep edge, showing the extent of the gravel, being distinctly apparent. This gravel is of doubtful age, but certainly as old as Middle Glacial, similar gravels, of which the beds covering these two hills seem to be portions, elsewhere running under boulder-clay.

A few minutes' walk brought the party to Woodcock Hill Kiln, where sections of the Woolwich and Reading Beds and of the basement-bed of the London Clay were seen. As these sections

* See 'Trans. Herts Nat. Hist. Soc.,' Vol. IV, p. xvii.

† The Metropolitan Station was opened in September.

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seemed to be in the same state as when visited by the Society in 1882, when an account of them, with a section of the beds in the higher pit, appeared in the 'Transactions' (Vol. II, p. xxix), they need not here receive any further mention.

After a pleasant stroll across the fields, by woods in which the bluebell was flowering in profusion, giving them a rich carpet of blue, the high road from Rickmansworth to Pinner was reached. This road borders Moor Park from Rickmansworth to Batchworth Heath, a distance of a mile and a half, one-third of which was now traversed to arrive at the Heath.

At Batchworth Heath, the name formerly of the common, now of the hamlet of cottages surrounding the common-land, we have again a gravel-capped hill, 360 feet above sea-level; but here the gravel, a pebble-gravel like that before visited, is on the London Clay. This point commands extensive views of the country to the south and east. Below, on the south, lies Ruislip Reservoir, and far beyond are seen the hills of Surrey; on the east are Pinner Hill and Oxhey Woods, and between, beyond Pinner on its inlier of Woolwich and Reading Beds, stands out Harrow Hill on the London Clay capped by an outlier of the Bagshot Sands, which sands have preserved, and still are preserving, the summit of the hill from denudation, achieving, but on a larger scale, that which the bed of gravel first visited has done for its little hill.

Entering Moor Park, and still traversing the bed of pebble-gravel, Cardinal Wolsey's oak was pointed out on the left—a tree not planted by him, but under which, it is believed, was his favourite seat; and all around were seen the oaks pollarded by order of the Duchess of Monmouth on her husband's execution in 1685, most probably from the desire to prevent them from ever being used as timber for the Royal Navy.*

The "Upper" or "Old Pleasure Grounds" were then visited, by the kind permission of Lord Ebury. These grounds are about twenty-five acres in extent, and they command a fine view of the country to the north, beyond the valley of the Colne. The boundary of the Batchworth Heath gravel-bed passes across them, and the London Clay on which it rests holds up the water which percolates through the gravel, a circumstance which has been taken advantage of in forming an ornamental sheet of water in the centre of the grounds, which adds much to their picturesqueness.

Almost too long did the party linger in these beautiful grounds, which were left with reluctance only just in time to catch the train to Watford, to visit Watford House, where Dr. Brett entertained the members of the two Societies with refreshments on the lawn. The assembled company, to the number of thirty-four—not all who had taken part in the meeting, for some had to go on direct to London—were photographed, and the proceedings of the afternoon were brought to a close.

* See 'Trans. Herts Nat. Hist. Soc.,' Vol. II, p. 14.

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Field Meeting, 11th June, 1887.

BERKHAMSTED, ASHRIDGE, AND ALDBURY.

On arrival at Berkhamsted Station at noon, the party, under the direction of Mr. Littleboy, proceeded to the Castle grounds, and, assembling on the top of the mount, listened to a paper by the Director on Berkhamsted and its castle.

Mr. Littleboy first alluded to the different ways of spelling Berkhamsted, of which he said there were ninety-nine. The earliest record was in the Anglo-Saxon Chronicle, where it is written Berkhamstede (a spelling we have now reverted to, dropping the last e); in Domesday Book it was Berckehamstede; in Latin chronicles, Beorcham. Dr. Stukeley maintained that Berkhamsted stands upon the site of the ancient British town of Durocobrivis, the city of the marshy stream, but this honour had also been claimed by Dunstable, Redbourn, and Hertford. It might be interesting to notice the earliest relic of British workmanship to be found in the district. On the Common, just above Frithsden, might be observed a long bank or dyke, locally known as "Grymes Dyke." It was probably an ancient British earthwork, encircling Berkhamsted and running by the top of a meadow at the back of Boxwells and across the country to Missenden and Wendover. After stating that during the occupation of England by the Romans the legions of the empire marched from Verulam along the valley of the Bulborne past Berkhamsted, Mr. Littleboy gave at some length the comparatively modern history of the castle, commencing with the year 1066, and concluded with an allusion to its present state of ruin, in which

> "Still the deep moat in silence round it steals,
> And the high mound its ancient pride reveals."

Leaving the Castle, the party proceeded across Berkhamsted Common to Ashridge, having lunch on the way under a group of beech-trees. In Ashridge Park the "Queen's Beech" was viewed. It is a fine straight-grown tree attaining a height of ninety feet before throwing out its first branch. The Bridgewater Column was then ascended, and, from the top, the atmosphere being clear, a splendid view was obtained, the main features of which have been described in the reports of previous visits. After descending the hill to the village of Aldbury, tea was partaken of at the "Greyhound," and Tring Station was reached in time for the seven o'clock up train.

On the chalk slopes below the Column a few orchids and other interesting plants were found, but none which have not previously been recorded from here, and the only plant obtained of which there is no previous record for the locality was *Cerastium arvense*, which was found in a field between Aldbury and Tring Station.

The day was not a favourable one for entomologists, for, although the sun was shining brightly, there was a strong breeze blowing, and consequently very few insects were to be seen on the wing, even in the more sheltered spots. Beating amongst the bushes and

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undergrowth in Berkhamsted Castle failed to dislodge a single specimen. On the Common a peacock butterfly (*Vanessa Io*) was captured, whilst among the furze bushes that ubiquitous little tortrix, *Grapholita ulicetana*, flew in swarms. When the woods between Ashridge House and the Monument were reached, the force of the wind had somewhat abated, and in the sheltered ridings the pearl-bordered fritillary (*Argynnis euphrosyne*) was flying. Beating in the ferns and ling was rewarded by the capture of *Panagra petraria* and *Melanippe rivata* in abundance, and also of one specimen of the barred hook tip (*Platypteryx unguicula*) and one of a remarkably small variety of the garden carpet moth (*Melanippe fluctuata*). The slopes of Moneybury Hill produced *Pygæra bucephala*, which was caught at rest beneath a tree, the common blue butterfly (*Polyommatus alexis*), the dingy skipper (*Hesperia tages*), and *Crambus pratellus*. *Depressaria arenella*, *Dasycera sulphurella*, *Elachista cygnipennella*, and one or two other small moths were caught by beating the hedges in the neighbourhood of Aldbury.*

Field Meeting, 18th June, 1887.

ST. ALBANS.

The object of this meeting was to record the species of plants seen in flower, as was done in an evening walk taken by a few members of the Society in the neighbourhood of St. Albans some years ago (28th June, 1880).† On that occasion 87 species were found in flower—on this the number was rather less.

Assembling at the London and North-Western Station, the members walked by the River Ver to St. Michael's, and then, crossing the Redbourn Road, up a lane which leads into the Harpenden Road. The upper part of this lane, which was stated to have probably been an old British trackway, is now disused and overgrown, and, the afternoon being hot and bright, the shade afforded by the trees which here meet overhead was very welcome, and so also was the soft grass under foot. Taking the Harpenden Road for a short distance towards St. Albans, Beech Bottom, generally supposed to be a pre-Roman defensive earthwork, was strolled through, and then Bernard's Heath was crossed to St. Peter's, where the members and their friends were entertained at tea, at The Grange, by Mr. and Mrs. Hopkinson. By this time the party, small at starting, had increased to about forty.

After tea, which was partaken of on the lawn, a photograph of the party was taken, a number of Entomostraca and other microscopic creatures were collected from a pond in the meadow and examined under the microscope, and, as soon as it was sufficiently dark, Jupiter and Venus were examined through an equatorial telescope.

* For this account of the entomological results of the meeting I am indebted to Mr. A. E. Gibbs, F.L.S.—Ed.

† See 'Trans. Herts Nat. Hist. Soc.,' Vol. I, p. xliii.

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The following are the species of plants seen in flower, Mr. Hopkinson acting as Recorder:—

Ranunculus repens, L.
,, *acris*, L.
,, *auricomus*, L.
,, *bulbosus*, L.
Batrachium pseudo-fluitans, Pryor.
Papaver Rhœas, L.
Chelidonium majus, L.
Fumaria officinalis, L.
Alliaria officinalis, Andrz.
Sisymbrium officinale, Scop.
Sinapis nigra, L.
,, *arvensis*, L.
Thlaspi arvense, L.
Capsella Bursa-pastoris, Moench.
Viola canina, L.
Melandryum silvestre, Roehl.
,, *pratense*, Roehl.
Stellaria media, Cyr.
,, *Holostea*, L.
,, *graminea*, L.
Acer pseudo-platanus, L.
,, *campestris*, L.
Geranium dissectum, L.
,, *Robertianum*, L.
Oxalis Acetosella, L.
Ulex europæus, L.
Trifolium pratense, L.
,, *repens*, L.
,, *procumbens*, L.
Lotus corniculatus, L.
Lathyrus pratensis, L.
Vicia sepium, L.
Rubus fruticosus, L.*
Fragaria vesca, L.
Potentilla Anserina, L.
Geum urbanum, L.
Rosa canina, L.
Cratægus oxyacantha, L.
Bryonia dioica, Jacq.
Chærophyllum temulum, L.
Anthriscus silvestris, Hoffm.
Sanicula europæa, L.
Cornus sanguinea, L.
Viburnum lantana, L.
Sambucus nigra, L.
Lonicera Periclymenium, L. (bud).
Galium aparine, L.
Senecio vulgaris, L.
Achillea Millefolium, L.
Leucanthemum vulgare, Lam.
Bellis perennis, L.
Circium lanceolatum, Scop.
,, *arvense*, Scop.
Centaurea nigra, L. (bud).
Lactuca muralis, DC.
Taraxacum officinale, Weber.
Hieracium Pilosella, L.
Crepis virens, L.
Myosotis intermedia, Link.
Solanum Dulcamara, L.
Scrophularia nodosa, L.
Veronica Chamædrys, L.
Ajuga reptans, L.
Lamium album, L.
,, *purpureum*, L.
Galeobdolon luteum, Huds.
Stachys silvatica, L.
,, *arvensis*, L.
Glechoma hederacea, L.
Lysimachia nemorum, L.
Plantago lanceolata, L.
,, *major*, L.
Rumex Acetosa, L.
,, *Acetosella*, L.
Urtica dioica, L.
Orchis mascula, L.
Tamus communis, L.
Scilla nutans, Sm.

Field Meeting, 13th October, 1887.

BROXBOURNE.

Hitherto the Fungus Forays of the Hertfordshire Society have been held in the western part of the county, in the neighbourhood of Watford and St. Albans, this—the sixth annual Foray—being the first held in the eastern part.

The party assembled at Broxbourne Station and walked thence through the lanes to Baas Hill and on from there to Broxbourne Common, returning by the Wormley West End Avenue through the woods to Carnell's Green. Wormleybury, the residence of Mr. H. J. Bushby, was then visited; and the members were very kindly entertained at tea. The weather was rather showery, but not so wet as to interfere with the pleasure of the walk.

* Its segregates were not determined.

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Dr. M. C. Cooke, who was with the party, gives the following list of species found:—

HYMENOMYCETES.

Agaricus (*Amanita*) *phalloides*, Fr.
" " *pantherinus*, DC.
" " *rubescens*, Pers.
" (*Lepiota*) *procerus*, Scop.
" " *granulosus*, Batsch.
" (*Armillaria*) *melleus*, Vahl.
" (*Tricholoma*) *sejunctus*, Sow.
" " *albo-brunneus*, Pers.
" " *saponaceus*, Fr.
" " *personatus*, Fr.
" " *nudus*, Bull.
" (*Clitocybe*) *nebularis*, Batsch.
" " *odorus*, Bull.
" " *laccatus*, Scop.
" " " var. *amethystinus*.
" (*Collybia*) *radicatus*, Fr.
" " *butyraceus*, Bull.
" " *confluens*, Pers.
" " *dryophyllus*, Bull.
" (*Mycena*) *purus*, Pers.
" " *galericulatus*, Scop.
" " *epipterygius*, Scop.
" " *amicus*, Fr.
" " *metatus*, Fr.
" (*Entoloma*) *lividus*, Fr.
" (*Clitopilus*) *prunulus*, Scop.
" (*Pholiota*) *terrigenus*, Fr.
" (*Hebeloma*) *geophyllus*, Sow.
" " *crustuliniformis*, Bull.
" (*Flammula*) *carbonarius*, Fr.
" (*Tubaria*) *furfurascens*, Pers.
" (*Stropharia*) *æruginosus*, Curt.
" " *semiglobatus*, Batsch.
" (*Hypholoma*) *sublateritius*, Schæff.
" " *fasciculare*, Huds.
" " *velutinus*, Pers.
" (*Psilocybe*) *spadiceus*, Schæff.
Coprinus comatus, Fr.
" *niveus*, Fr.
Cortinarius (*Phlegmacium*) *varius*, Fr.
" (*Myxacium*) *elatior*, Fr.
" " *mucifluus*, Fr.
" (*Dermocybe*) *caninus*, Fr.
" " *ochroleucus*, Fr.
" (*Telamonia*) *hinnuleus*, Fr.
" " *rigidus*, Fr.
" (*Hydrocybe*) *decipiens*, Fr.
Hygrophorus chlorophanus, Fr.
" *psittacinus*, Fr.
Lactarius pyrogalus, Fr.
" *mitissimus*, Fr.
" *subdulcis*, Fr.
" *exsuccus*, Sm.
" *blennius*, Fr.
" *cemicarius*, Batsch.
" *piperatus*, Fr.
Russula nigricans, Fr.
" *furcata*, Fr.
" *depallens*, Fr.
" *cyanoxantha*, Fr.
" *alutacea*, Fr.
" *lutea*, Fr.
" *nauseosa*, Fr.
Marasmius peronatus, Fr.
" *oreades*, Fr.
" *epiphyllus*, Fr.
Boletus chrysenteron, Fr.
" *edulis*, Bull.
" *scaber*, Fr.
Polyporus giganteus, Fr.
" *adustus*, Willd.
" *versicolor*, L.
" *vaporarius*, Fr.
Tremella mesenterica, Retz.

ASCOMYCETES.

Peziza vesiculosa, Bull.

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TRANSACTIONS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY.

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I.

ANNIVERSARY ADDRESS.

By the PRESIDENT, PROFESSOR JOHN ATTFIELD, Ph.D., F.R.S., F.I.C., F.C.S., etc.

Delivered at the Annual Meeting, 16th February, 1886, at Watford.

THE LAWS OF GOD IN NATURE.

Let knowledge grow from more to more,
But more of reverence in us dwell;
That mind and soul according well,
May make one music as before,
But vaster . . . . . .—*Tennyson.*

So comprehensive a subject as the Laws of Nature demands the life-thoughts of the most powerful minds, and their record in many series of volumes. For although by *laws* we may mean only the greater truths, or, as they will presently be termed, decrees which govern the materials and the forces of nature, yet these cannot be considered without some reference to the materials and forces themselves, and cannot be described without illustrations drawn from every department of nature. Goethe felt this all-embracing character of the subject, but at the same time saw the importance of the how and why, the interest attached to the linking of cause with effect in nature, in a word the relation of nature to law, when he made Faust thus soliloquise over the sign of Macrocosmos, that is, over the whole of nature external to himself:—

"How all things live and work, and ever blending,
Weave one vast whole from Being's ample range!
How powers celestial, rising and descending,
Their golden buckets ceaseless interchange!
Their flight on rapture-breathing pinions winging,
From heaven to earth their genial influence bringing,
Through the wide whole their chimes melodious ringing.

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"A wondrous show! but ah! a show alone!
Where shall I grasp thee, infinite nature, where?"

Yet, so simple and so fascinating is this grand theme, that children may be charmed by it and youth find in it never-failing materials for wonder and delight. Longfellow happily expresses this in his word-picture of the childhood of the great Swiss (afterwards American) naturalist Agassiz:—

And Nature, the old nurse, took
The child upon her knee,
Saying: "Here is a story-book
Thy father has written for thee."

"Come wander with me," she said,
"Into regions yet untrod;
And read what is still unread
In the manuscripts of God."

And he wandered away and away
With Nature, the dear old nurse,
Who sang to him night and day
The rhymes of the universe.

And whenever the way seemed long,
Or his heart began to fail,
She would sing a more wonderful song,
Or tell a more wonderful tale.

In truth, the subject of the Laws of Nature is many-sided, and may quite fittingly be considered by the members of a Natural History Society, and may quite properly be introduced to their notice in the few paragraphs of a modest address by their president. Indeed, remembering how instinctive is the desire for natural knowledge, and how rarely the questions of children respecting nature can be answered satisfactorily by their elders, we may well ask what branch of knowledge stands more in need of intelligent home-teaching, and who so appropriately can prompt a desire for, and in various ways promote this teaching, as the officers and members of societies founded for the study of nature and for the dissemination of truth respecting nature. There are nearly two hundred Natural History Societies in Great Britain and Ireland, most of them limiting the area of their work to the study of the nature of the animals, vegetables, and minerals of their respective districts, as well as to the record of the amounts of rain and sunshine with which they may be favoured, and of the varying pressure of the air, whether at rest or in motion. The injunction which animated the sightless yet far-seeing patriot recently snatched from us, and which now eloquently appeals to us from his tombstone in a Cambridgeshire churchyard, "Speak unto the people that they go forward," may, as regards progress in the knowledge of nature, nobly animate the officers and members of

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Natural History Societies. For each individual of such societies may, in his own sphere and in his relation to his fellow members, also usefully take these words as his motto, and, perhaps extending the scope of his work from the zoology, botany, geology, and meteorology of his district to the wider consideration of the forces which actuate and the laws which govern visible things, may materially aid in showing the world in what way the great decalogue's first words, "Thou shalt have none other gods before me," are written on every stone, leaf, and moving thing on this earth, on the water that fills its hollows as well as on the atmosphere that floats above its mountains, and on the nebulæ, planets, and suns of the universe.

So far, this address has only treated of the Laws of Nature. But the title of the address is the Laws of God in Nature. Now, reference to competent authorities will show that in the strictest sense 'law' relates to persons, and is a general decree by one intelligent being respecting another intelligent being, as, for example, what is usually regarded as a 'law' of God in relation to the conduct of man, or a 'law' obtaining in any state as between those who rule or govern and those who are governed. In a less strict sense, law relates not to persons but to things or phenomena, and is such a relationship of cause and effect as is more or less analogous to a decree between intelligent beings, as, for example, the 'law' of gravitation. In both senses the term 'law' is applied only to great leading truths, whether relating to persons or to things. But the title of this address includes, and is intended to include, not only the great relationship alluded to between one being and another being, and one thing or phenomenon and another thing or phenomenon, but between a being and a thing or phenomenon, and is designed to express the conviction of the vast majority of mankind in every quarter of the globe that the natural laws which relate to things and to phenomena generally are the decrees of a Being.

From what has just been stated it will be evident that in no narrow spirit can we contemplate the Laws of God in Nature. Every sect in the Christian religion believes that "in the beginning God created the heaven and the earth"; but this God is not alone the God of the Christian. That in this belief in a God who is the creator of nature the Jew is one with the Christian, is obvious when we remember that the sentence just quoted is the first which occurs in the Hebrew Scriptures. The millions of Islam believe in the one God, their Koran, or Qur'an (*chap.* xlvi, *ver.* 32, *Palmer's Trans.*), teaching them of "God who created the heavens and the

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earth." The large portion of the human race inhabiting China are chiefly the followers of the great teacher Confucius, and, as Clodd says, "he, of all men, had reverence for the sacred unknown power that underlies all things." Buddhism, said to have a greater following than any other single religion, "seems mainly to rest on the principle that the world, and sensible objects contained in it, are manifestations of the Deity."—*Eng. Cyclo.* The Pârsîs, the comparatively few surviving followers of Zoroaster, the founder of the ancient religion of Persia, fear a God who is Mazdâ or Creator of All. Brahmanism or Hinduism, which includes one-tenth of the human race, comprises not only the worship of that which maintains (Vishnu), and that which destroys (Siva), but of Brahma the creative power, called also Great Father, Lord of Creatures, Ruler of the World.

"Mighty Brahma, now I'll bless thee!
'Tis from thee that worlds proceed!
As my ruler I confess thee,
For of all thou takest heed."
—*Goethe*, The Pariah's Thanks.

In short, as Max Müller says in the preface to vol. i. of 'Chips from a German Workshop,' "An intuition of God, a sense of human weakness and dependence, *a belief in a Divine government of the world*" [the italics are the writer's], "a distinction between good and evil, and a hope of a better life, these are some of the radical elements of all religions." Even the materialist does not actually deny the existence of a creator and maintainer of the universe; while the so-called atheist, if you will only let him use some other word than God, will gladly contemplate those laws of nature which even he recognises as altogether superhuman.

Looking at the subject broadly, therefore, a knowledge of the laws of nature regarded as the laws of God is of the deepest interest to all human beings who are assured of the existence of God, be they Brahmans, Pârsîs, Buddhists, Muslims, Jews, or Christians. And to the comparatively few who hold no such belief a knowledge of the laws of nature is of equal interest: nay, one would suppose that this knowledge would, by the ordinary process of induction, lead these persons, at least tentatively, to hold to the existence of some such great outside agency. And here one may parenthetically remark that it seems to be unavoidable for some minds to place the natural in opposition or competition to the supernatural. The natural seems to them to be so satisfying, so sufficiently superhuman, that it is their *ultima Thule*. To the great majority of minds, however, it is as impossible to regard the natural without by a simple process of inference reaching towards the

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supernatural, "as it would be for an intelligent savage to regard a watch without inferring the existence of a watchmaker." The reverent student of nature reasons thus:—"From natural causes and their effects or results I infer a prime cause. Behind that cause I cannot go. I may believe, but I cannot comprehend the genesis of matter and force, nor have I yet found any one who can." Let us not be misled by mere terms. Effect and cause, in the kingdoms of nature, are, apparently, possible of comprehension. Further, a supernatural cause of all natural cause and effect may be inferred—even if no sacred book of the east had ever existed. Beyond this it would seem to be impossible for mere imagination to proceed. But the point now urged is that even to the few persons who seem to be unable to look from nature up to nature's God, as to all other persons, the essential portions of such an essay as the present may be addressed.

So, then, mankind in general, probably every human being except the mindless and the depraved, is interested in the consideration of the Laws of God in Nature. From the common platform occupied by the many preachers on this subject, therefore, the differences, nay hatreds, which too often characterise the followers of all religions, may be excluded; while every man, woman, and child who endeavours to comprehend those laws, and to regulate daily existence in accordance therewith, may live a healthier, happier, and longer life, sleep a sounder and more refreshing sleep, and possess an unfailing standard of truth whereby to measure the political, social, moral, and much of the religious relations of life. Nay, more, not only will a proper comprehension of the Laws of God in Nature promote the welfare of one's self, but, like the proper use of every kind of knowledge we may possess, it will promote the welfare of all within our influence. For, as Lord Bacon, the greatest orator and philosopher of his times, states, in his 'Advancement of Learning,'—that Bacon, who, as Francis Baron Verulam, Viscount St. Alban's, of Gorhambury, was perhaps the greatest genius Hertfordshire ever possessed—"the greatest error of all is, mistaking the ultimate end of knowledge; for some men covet knowledge out of a natural curiosity and inquisitive temper; some to entertain the mind with variety and delight; some for ornament and reputation; some for victory and contention; many for lucre and a livelihood; and but few for employing the Divine gift of reason to the use and benefit of mankind."

The terms of the title of this Address, "The Laws of God in Nature," exclude any reference to spiritual laws. Nor would the

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author presume to speak of moral laws. The laws of mind, too, he is unable to consider. Laws as governing evolution in nature, and as directing political and social phenomena, do not admit of treatment within the limits of an hour's address. The laws to which attention is now invited are, generally, those, and, specially, illustrations of those, by which are maintained the structures of man himself and of the whole of the animal and vegetable kingdoms, this world and its investing atmosphere, and indeed the whole of the visible universe. Further, it will be obvious, from what has already been stated, that by the word *law* is to be understood *that which is decreed*, whether by the human for the human, by the superhuman for the human and for the animate generally, or by the superhuman for the inanimate. Frequently only those particular decrees or greater natural truths which admit of expression in mathematical terms are regarded as *laws*, lesser truths being named *principles* and *generalisations*, while afterwards come those more localised truths known as *properties* of matter or of force. The property of indestructibility of matter and of force is, however, so universal, so important, so great a link between cause and effect, so great a truth—a truth decreed to govern all matter and all force—that it would seem to be as much a law or decree as any of the great general truths that admit of statement in terms of time or space or number, and it therefore will here be so treated.

Of the Laws of God in Nature, as thus defined, perhaps the first to strike the enquiring mind is that of the indestructibility of matter by any means known to us or of which we can conceive. You throw a letter into the fire, it burns, and you say you have destroyed it. But is it really destroyed? As a letter, it is. The form of the thing has been destroyed, no doubt. It is easy to alter the form of matter. But is one single particle of the matter of which the sheet of paper consisted actually destroyed? Not one. Is one particle of the paper, wood, coal, coke, charcoal, or whatever you put into your fire-grates and furnaces destroyed? Not one. Burn twelve parts—pounds or grains, say pounds—burn twelve pounds of coke, pure coke, that is, coke without ash. Or, which is tantamount, ascertain the proportion of ash or other extraneous matter in the crude coke, and, allowing for this, thoroughly burn so much of the crude coke as contains twelve pounds of pure coke. The coke will make a clear fire, the product of the combustion, which passes up the chimney, being invisible. Though invisible, however, it is perfectly tangible and capable of producing very tangible effects; for if you burned the coke in a room without a chimney you would be suffocated by the same invisible product of combustion. Now

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so arrange your chimney as to collect this invisible gaseous product of the burning of the coke—an easily-managed operation which on a small scale has been performed by thousands of persons many thousands of times. And having collected it, weigh it. It will weigh practically forty-four pounds (actually 43·92). The twelve pounds of pure coke have taken thirty-two (actually 31·92) pounds of that part of the air which enables it to burn—for, as everybody knows, you cannot burn fuel without air—and has produced forty-two pounds of chimney-gas, which is invisible, it is true, like the air itself, but which is perfectly definite, perfectly tangible, and which has been proved over and over again to contain the twelve pounds of pure coke. But any one may demonstrate this truth for himself, for the laws of God in nature do not necessarily demand faith. Deal properly with the forty-two parts of chimney-gas and it will yield to you the twelve parts of coke you started with. The operation is costly; the recovered coke will cost you many more sovereigns than commercially it is worth pence; but it is an operation that has been performed by hundreds of men who in their desire and their search for truth care not what money, time, or effort they spend. What is the conclusion from the experiment? It is this, that you may alter the *form* of the matter, you may convert visible black hard coke into invisible colourless soft gas, but you cannot actually destroy the coke. And what has been demonstrated respecting coke has been demonstrated—rigidly demonstrated by the most delicate balances—as regards hundreds of thousands of other substances. Nature knows not waste, knows not loss. You are daily converting your coal, your oil, your candles, your wood, into gases which pass either directly or through chimneys into the air, becoming, like the air, invisible, inodorous, tasteless; but your trees and shrubs absorb those gases, reconvert them into oil or wood, etc., which sooner or later are again used as fuel for your fires and flames, to be again sent on their ceaseless round. One more illustration, again drawn from the incidents of every-day life, of the great truth or law of the indestructibility of matter. You eat food. A portion of that food, performing its appointed work within you, enables you to think and act, another portion burning inside you gives you that bodily warmth without which you could not live. Are the elements of the food destroyed? Not a single one of the particles. These, having done their duty, pass to the air above us or to the ground beneath. From the air and from the ground the vegetable again withdraws them, and with them builds up its own structure, sooner or later possibly to re-appear on our table, fresh from the glorious laboratory

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of nature, ready again for the use of man. Shakespeare was a true seer when he put into the mouth of Ariel the ditty which, while it recalled to Prince Ferdinand the memory of a drowned father, also led the Prince to reflect, with an amount of truth unheeded by Prospero, "this is no mortal business, nor no sound that the earth owes." Ariel sings:—

"Full fathom five thy father lies;
Of his bones are coral made;
Those are pearls that were his eyes;
Nothing of him that doth fade
But doth suffer a sea-change
Into something rich and strange."

That which the bard apparently foresaw, some three centuries ago, the modern student has proved. In their patient search for truth a few earnest men, chiefly during the past hundred years, have thread by thread removed the veil that from time immemorial has hidden the law of the indestructibility of matter from our eyes. Who decreed that law? Not man.

Of the Laws of God in Nature, quite as striking a law as that just alluded to is the law of the indestructibility of force: perhaps, indeed, more striking because of the pre-eminently striking character of force itself. For power, energy, or force, seems to belong, if possible, to a higher order of creation than matter—matter being limited in its area and having place assigned to it, while force is all-pervading; force ever filling and ever traversing the interstellar spaces as well as ever governing the matter which forms the moons, planets, and suns of the universe. By force is meant that which causes motion, that which actuates matter: whether the force be manifested by the muscle of an animal, the power of an engine, the stroke of the lightning; by the silent attraction of the magnet or the warmth of the sun; by the quiet but irresistible chemical power which converts one form of matter into another; or by light, to which alike the glorious rainbow and the modest violet owe their lovely hues. Force, like matter, is indestructible, by any means known to us or of which we can conceive.

To realise the indestructibility of force let us follow in imagination the associated forces of heat and light as they, possibly with other forces, impinge on the leaves of trees in summer. The forces are absorbed, the leaves and the woody tissue with which the leaves are linked undergoing a consequent change in chemical character: in common language the leaves and wood grow; the change and the growth being so dependent on the light and heat that neither change nor growth would take place in the absence of light and heat, even though the air and soil supplied the materials for growth as usual. Time passes and we put the logs of those

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trees into a grate and ignite them. What happens? The original light and heat they absorbed from the sun, temporarily stored in their tissues as chemical force, comes out of them again as light and as heat, warming and cheering us in our dwellings and promoting our health and our comfort. The actual material of those logs, as material only, is useless to us. What is useful is the heat and the light which that material has stored up. The material itself is costly to grow, costly to hew, costly to store. We put it into our fire-grates, but, as already shown, we cannot truly destroy it, we can only convert it into gas which passes out into the atmosphere through costly chimneys. Why do we incur all this cost? To get back from that troublesome and costly material its store of invisible and imponderable but indestructible latent life-giving forces. As with wood, so with coal. Regarded as mere matter, and from the point of view of the user, the coal itself is a costly and useless nuisance from the time it enters the cellar to the time it escapes from the chimney-top. But without it we cannot have its associated light and heat; those forces which it borrowed from the sun ages ago when it was a growing forest; forces never lost, never wasted, never destroyed. The matter of our fuel is indestructible, the power or energy or force carried within that fuel or food is indestructible also. We can change the form of a force, but we cannot destroy it. Thus we can put the fuel with its contained force under a boiler of water, and, igniting the fuel, can provide for the escape of the material of the fuel by a chimney, while we transfer to the water the force which the fuel carried, making the water boil, that is, making the particles of the water fly asunder with almost irresistible motion and produce steam. The force of heat having thus been converted into motion, we, throwing aside the steam itself by any convenient means, communicate its motion to pistons, cranks, and wheels, and so get various effects useful to man. Possibly by the aid of wheels and bands we change this force of motion into the force of magnetism, or into the force of electricity. The latter we can pass along a wire until it meets with an obstructing wire, when immediately it is changed into the force of light, and we get the so-called incandescent electric light. Or we may convey the electric force into water, a separation of whose elements resulting, gives us an opportunity, through the silent agency of the chemical force, of getting heat from the oxy-hydrogen jet, and a conversion of that heat into light if we place anything which can be made white hot within the jet. Here then is a whole series of transformations of force. First noticing it as light and heat, we find it changed into chemical force,

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back into heat, this into motion, motion into magnetism, the magnetism into electricity, this into light, or into motion, or into chemical force, this into heat, the heat once more being converted into light. Transformation, always; apparent dissipation, rarely; destruction, never!

The story of the relations of fuel and its associated force and the indestructibility of both, is the story of the relations of food and its associated force and the indestructibility of both. Light and heat shine upon the edible as on all the vegetables of prairie and forest, field and garden. These forces are stored up within the respective vegetables as chemical force; animals eat the vegetables, and immediately a portion of the latent force is changed into the form of heat which keeps the animal warm, another portion being transformed into mechanical force, as when the man, horse, or other animal walks. Perhaps the man transfers some of the force through his arm and hand to the spring of a watch or a clock enabling it to "go," or to a hammer enabling it to hit, or to the brain enabling it to think, and to the hand enabling it to write. The ultimate particles of food, as mere material particles or atoms, are useless to us. It is their stores of force that we need in order that we may exert force, or, in other words, their stores of energy that we want in order that we may energise, their stores of power in order that we may be powerful. Of that force, however, as of the matter of our food, we are but stewards, passing both on in their ceaseless round of transformations, in quality unimpaired, in quantity undiminished, but in direction possibly more or less changed—not always involuntarily changed, but sometimes usefully changed, often harmlessly changed (seldom, let us hope, harmfully changed), by the exercise of the mysterious Will within us.

We cannot always trace force through all its subtle transformations, cannot yet in every case know whence a particular manifestation came or whither it has gone. But, on the other hand, in many cases we can not only follow its course, but measure its amount, then transform it and measure its amount in the new form, and even give its numerical equivalents in various forms, and thus actually demonstrate its imperishable nature. The patient search and toil of many men for truth has been rewarded in the gradual laying bare of the simple yet all-reaching fact or natural law that all force is indestructible. Who decreed this law? Not man.

The combination of simplicity with grandeur in The Laws of God in Nature is characteristic. Indeed, the rate at which they act, or the power with which they act, or the time in which they

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act, may commonly be expressed in some simple mathematical statement. Take, for example, the law of gravitation. We look at the sky on a cloudless night, and our first impression is that we are gazing at a star-studded roof or plane, looking at lamps in the dome of nature's cathedral. Remembering, however, that the earth is daily rotating on an axis, that a moon revolves around the earth, and the earth around the sun accompanied by some of those stars or, rather, planets, that at first sight seemed to be fixed in the great dome; and reflecting on some similar well-ascertained truths, as, for instance, that the so-called blueness of the sky is merely the blue colour of the air immediately surrounding our little globe: considering these facts, we begin to realise what patient workers at truth have long ago found out, namely, that the earth and her sister planets, though many millions of miles from each other and from their central sun, yet form but one small sun-group amongst vast numbers of sun-groups, the groups being scattered through illimitable space. Scattered heterogeneously? No. The prime law of order everywhere prevails. The position and motion of one planet affects, more or less, the position and motion of every other, while, doubtless, every orb in the universe is similarly influenced, each being attracted by each, and all being governed, not by myriads of laws of attraction, but by one law, namely, that of gravitation, the extent or power of which is expressed in the simple statement that it acts *directly as the mass and inversely as the square of the distance.* What gravitation is in its inner essence we know not. We know it only as we know any force, by its effects. But it governs the fall of an apple and the flight of birds or insects in the same simple manner that it guides the rush of Jupiter and the movements of the sun itself. Call it a decree passed respecting all matter, call it a law, call it a force, call it what you will, gravitation, and the principle just expressed mathematically respecting the manifestation of gravitation, are great all-reaching stupendous truths, yet simple all-perfect beautiful truths of nature. It has been decreed that material substances shall be indestructible, it has been decreed that material substances shall attract and be attracted in definite proportions. The statement as to the proportions may be termed a law, gravitation itself and other forces may be regarded as law, but, from the present point of view, it is the decrees respecting those material substances and those forces that are the prime laws as mankind generally regard laws. Who decreed these laws? Not man.

From the centripetal law of gravitation which governs the tendency of our earth to be attracted towards the sun, we might

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appropriately pass on to the opposing or rather balancing law regulating centrifugal force, which impels the earth to fly away from the sun; and so to the laws of the other macrocosmic forces, on the relations of which forces to one another the maintenance of the existing order of the universe would seem to depend. Not mere essays, however, but whole books would be necessary, even for the cursory treatment of these cosmical laws. For the purposes of this Address, however, what has already been stated should fully suffice in illustration of what may be termed the Macrocosmic Laws of God in Nature.

We may now turn for a little while to what for purposes of description may be termed the Microcosmic Laws of God in Nature, that is, we turn from the contemplation of two or three of the laws of the macrocosm or universe to the contemplation of a few of the laws which are more personal to the microcosm or man. Afterwards we may again consider laws which have both macrocosmic and microcosmic interest, laws both celestial and terrestrial.

Man lives under two chief conditions, he is either asleep or awake. Strictly speaking only a portion of our system can sleep. The heart and the lungs with their associated respiratory muscles never sleep—that is to say, not until they metaphorically sleep the long long sleep of what for them, as mere organs, is truly death. The heart is a perfectly-constructed pump, the action and work of which in pumping our life-blood are governed by the laws which govern the action and work of other pumps. The system of lungs and chest-muscles also may be regarded as a contraction-and-expansion apparatus or pump (in which diffusion does valve-work), an air-pump, the functions of which are controlled by the laws which control similar pumps. And these pumps, in our sleeping as in our waking hours, so gently force together the fluid in our veins and the all-purifying air, that by night we rest undisturbed and by day are alike unconscious both of the presence of these two engines and of the work they are ceaselessly performing. Study the mechanical laws which govern the action of the common water-pump and the less common but very simple air-pump, and you will understand the laws which govern the mechanical action of the heart and of the breathing-organs. But other laws are operating during respiration. How does the ever-inhaled air purify the ever-flowing blood? Here the laws of combustion come into play. Study the laws which govern the matter and force of our factory furnaces or of our household fires and flames, and you will understand the laws by virtue of which the air we breathe acts on the blood which flows through our veins. The food we eat is converted into blood under one series

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of laws, the blood coursing through our arteries so yields to us its stores of force by another series of laws as to enable us to work with brain or hands or feet under still another series of laws. But the blood in thus yielding its stores of power becomes powerless and effete, it is only fit for burning. And burned it is, within us; burned just as fuel is burned in a furnace or fire-grate; burned by action of the air drawn into the lungs; the heat evoked in the burning giving to us that warmth without which we could not live either asleep or awake, while the gaseous products of the combustion pass up through the little chimneys called the bronchial tubes and the larger chimney termed the throat, and so out by the general mouth to be diffused into the atmosphere. Whence came these laws or decrees governing the action of the heart and lungs, alike when we are asleep or when we are awake? They were not devised by any human agency, they record not the mandates of any human legislature.

The statement has just been made that the used-up air exhaled by the mouth in breathing is *diffused* into the atmosphere. This diffusion is worthy of our attention. For it is as important a property of matter, as important a truth or principle or law, in relation to man, as the indestructible character of matter or the gravitation of matter, though not so far-reaching. Why does not this impure exhaled air gather round our mouth and suffocate us, more especially when we are asleep and motionless? Why does not the similar product of combustion from our gas-flames, candle-flames, and oil-flames, accumulate in our rooms and suffocate us? Why does not the similar poisonous gas generated in our fire-grates and furnaces, and which is ever being conveyed by our chimneys into the layer of air close to the earth, accumulate there and poison us and all animals? It may perhaps be said that the law of gravitation indirectly comes into action; that the impure gas is warm and therefore less heavy than the colder air, and that for this reason it rises and passes away, its place being occupied by the adjacent pure air. All of which is true as regards the laws which momentarily come into action; but this action is only local, the warm air almost immediately acquiring the temperature of adjacent cool air. We still have to deal with the fact that vast volumes of impure and poisonous air are constantly being generated on the surface of the earth and yet do not accumulate on the surface and suffocate us. Nay, the chief impurity thus produced is a gas half as heavy again as air, and therefore one which, did it solely obey the law of gravitation, most certainly would accumulate below the lighter pure air. Here comes in that nice adjustment of law which

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obtains everywhere and always and which has already been hinted at in connection with the centripetal and centrifugal forces. If the impurities of respiration, coal-burning, and other cases of combustion obeyed the law of gravitation alone, these impurities would accumulate on the surface of the earth and would render all animal life impossible. They obey the law of gravitation; but they obey the law or decree of diffusion also, under which a heavier gas will pass up into a lighter notwithstanding gravitation, and a lighter will pass down into a heavier notwithstanding gravitation. And here we must allude to another law relating to diffusion; an arithmetical law expressive of the *rate* of diffusion—a law to which indeed the term 'law of diffusion' is sometimes restricted. Truth-seekers have experimentally measured the rates at which gases diffuse into one another, and at first sight the results seemed to show that gases diffused at rates as different as their specific weights. But soon it was evident that although the lighter gases diffused faster than the heavier, they did not do so exactly in proportion to their lightness. Further careful search detected the law. Gases do not diffuse at as many different rates as there are different gases, nor even at as many unrelated rates as there are gases of different relative weight, but they all diffuse at a rate which is simple and single in kind, namely, a rate inversely proportional to the square root of their relative weights. Thus a gas which is sixteen times as light as another will diffuse four times as fast as that other. These laws of diffusion and rate of diffusion come into play in respiration and in all varieties of ventilation. Manifestly it is in obedience to these laws that the impure gas expired from the lungs does not accumulate in the neighbourhood of one's mouth. Clearly it is in obedience to these laws that this heavy and, when concentrated, poisonous gas, yielded not only from the lungs but from all fires and flames, does not accumulate on the surface of the earth and render life impossible, but *diffuses* away into the air, becoming so diluted as to be harmless to man and all animals, and yet not so dilute but that it still is the food by which plants live and grow. If we are to live healthy lives as regards the inhalation of pure air and as regards the admission of pure air to our dwellings, some of us must study the laws of diffusion, respiration, and combustion. Knowledge of these laws is, in fact, beginning to be taught in all our higher schools and colleges in place of some of the classical teaching which formerly occupied so large a proportion of school hours.

From the superhuman laws which govern and protect us during sleep we naturally turn to those of the force which dispels darkness,

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turn to the laws which govern light, the laws of radiation, reflection, refraction, and colour. These all admit of arithmetical or geometrical expression. That is to say, using the word law, firstly, in its ordinary meaning of that which is laid or fixed or decreed respecting things or respecting phenomena, and secondly, as a name for the written mathematical expression of that which is laid or fixed or decreed in terms of number or time or space, we say first that it has been decreed—by superhuman authority—that the phenomenon of light shall possess the attributes of radiation, reflection, and refraction, and secondly, that these attributes shall be exerted in so regular and simple a manner that man shall have the power of discovering or unveiling them, and of describing them with mathematical precision. Law 1,—light radiates in straight lines and in every direction from any light-giving body. Imagine many hundreds of pieces of string stretched from a single point in the centre of a room downwards to every small space (say, every square foot) on the floor, upwards to every similar space on the ceiling, and sideways to every similar space on each of the walls, the strings all being straight and rigid, like the spines of a rolled-up hedgehog or "like quills upon the fretful porcupine." Those strings thus stretched from that centre roughly represent the manner and direction in which light radiates from a luminous centre, be that centre the flame of a rushlight, the arc of an electric lamp, our own beautiful moon, our glorious sun, or any one of those not less lovely stars that ever stud our sky. The light-strings or pencils or rays are, however, infinite in number, and are capable of travelling infinite distances, the few which come to this earth from the sun having travelled more than ninety millions of miles; while the enormous numbers that fly past our earth, or which are projected in all other directions from the sun, may travel many times that distance before they impinge on any heavenly body. Not only is the direction in which light travels definite, but (law 2) its velocity also is definite, being more than ten millions of miles a minute; the light of the sun taking rather more than eight minutes to reach us, while that of other suns or stars takes many years, so distant are they. Then, with regard to a third law of radiation, everybody knows that when we work or read by artificial light, we can see better if the lamp or candle is fairly near to the work or book than if it is some distance away; but what perhaps many of us have not realised is that as we recede further and further from the source of the light, the diminution in the amount of light goes on according to a simple law, namely, in inverse proportion to the square of the distance. That is to say,

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a certain amount of direct light from a candle falls on to a page of a book at a distance of one foot from the candle. Increase the distance to two feet. Of course you will now get not more but less light on the page, the greater the distance the less the light, the ratio is not direct but inverse. But it is not simply inverse; at double the distance you do not get half the light. If you have a given amount of direct light falling on the page at one foot from the candle, you will at two feet have not one-half but one-fourth the amount; at three feet you get only one-ninth, at four feet one-sixteenth. At ten feet from the candle you will only get on to your page from the candle itself one one-hundredth of the direct rays of light that it yielded at a distance of one foot. In short, light from any source whatever radiates in straight lines and with a definite velocity, while the extent to which it illuminates any object is inversely as the square of the distance of the object from the source of the light. So much for the laws of radiation.

But in reading the book, not only do direct rays go from the candle to the page, but direct rays which rush from the flame to the ceiling or walls of a room are, many of them, reflected, and thus we get reflected as well as direct rays of light on our page. Now equally simple and equally inflexible laws govern reflection as govern radiation of light, laws which operate whenever we 'look' at a thing, that is, whenever we so turn our eyes that the light which is being reflected from that thing shall shine into our eyes. The things which we term reflectors or mirrors are merely the things which unusually, perfectly, and evenly reflect light. Ingenious combinations of reflecting surfaces give the familiar kaleidoscope, the so-called ghost (Pepper's ghost) effects, and form the basis of many conjuring tricks, etc. The interesting fact, however, in connection with the subject now under consideration is this, namely, that no matter by what substance or thing the light is reflected—by a book, a mirror, a house, a tree, the ground, the moon, or by any one of the millions of objects that present themselves to the eye—by all objects the light is reflected not by as many millions of modes as there are millions of objects, but according to two simple laws. These laws can be understood by any persons who are able freely to converse about spaces, magnitudes, and numbers. The laws may be thus geometrically expressed: Law 1,—the ray of light which is reflected is in the same plane as that which shines on the object; while, according to law 2, if a ray of light be directed on to an object and be reflected by that object, and you raise a perpendicular rod or line from that object at the place where the ray strikes, then the angle made by the

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reflected ray and the rod is exactly equal to the angle made by the direct ray and the rod. Armed with these two laws you may solve every apparent mystery connected with the reflection of light.

The laws governing the refraction of light—that is, the re-direction which light takes when it passes from one medium to another, as from the air into glass—are only less simple and far-reaching than those of reflection. There comes to nearly everybody a time of life when they must use spectacles. What does each curved piece of glass, each lens, do for us? It so re-directs, or makes a bend or break in the direction of, or, to use the best word, refracts all the rays of light that are reflected to the eye by an object, as to enable the eye to receive those rays as the unimpaired eye of childhood or youth receives them. Would you understand the action of the simple telescope, or of the double telescope commonly termed an opera-glass, or of the stereoscope, or of the camera-lucida, or of the photographic camera, or of the magic lantern, or of the simple or compound microscope, or of that most beautiful of all optical instruments the human eye; or why, when we partly immerse a stick in water, "all we have power to see is a straight staff bent in a pool"? Study the laws of the refraction of light. The first of those laws may be expressed by saying that the light which is refracted is in the same plane as that which shines on the refracting medium, whether the medium be water, glass, a gem, or other substance. The second law admits of geometrical statement, and has reference to certain characters of the angles made by the direct ray and the refracted ray with a common perpendicular. The resulting ratio furnishes a quantitative index of refraction. Thus water is more refractive than air to the extent that the number 1340 is greater than 1000, glass being represented by the figures 1530 to 1640 according to its composition, while the lovely gem the sapphire would stand at about 1800, and the greatest of all brilliantly refracting substances, the diamond, at 2450 to 2750 according to its chemical purity.

The great truths or decrees or laws which result in the production of all colour in nature can only be glanced at. The sun's light shines on drops of rain which refract, reflect, and so decompose the white light into its constituent colours, as to produce a grand spectrum, commonly called a rainbow. The water-drops in the spray of a fountain or those forced up by the bow of a rapid steam-vessel give similar spectra. A prism or wedge of glass gives such a spectrum. Certain pigments in nature, as the colouring matter of the rose, and certain pigments made by man's art, as mauve and

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magenta, have impressed upon them by superhuman decree the power of similarly decomposing light and yielding colour. For, be it observed, colour is a property of the light which shines on substances and not of the substances themselves; or, as Hill poetically expresses it, "light is the pencil with which God paints in all the hues of creation." Thus we say the grass is green, while the fact is that every blade contains a certain substance which has the power given to it of decomposing white light and of absorbing most of the resulting colours but of reflecting the green rays. The green rays of the original white beam of light are just those which are not taken up by the leaf; they no sooner impinge on the leaf than they are reflected away from the leaf and some of them entering the eye of an observer produce the effect of greenness. Thus regarded, the leaf itself is anything but green. But if by greenness we mean that the leaf has the power of reflecting green light, then the leaf is rightly termed green. Certain other properties of spectra are derived from special elementary metals and other elements in a state of incandescence; hence when these properties present themselves in the light of, for example, the sun, the necessary conclusion is that those metals or elements are present in the sun—and even in the stars and in the irresolvable nebulæ.

But the laws which rule in interstellar space or even in our solar system cannot be further considered within the limits of an anniversary address. The laws of heat are as striking and all-ruling as those of light, can equally easily be grasped by man, and can be expressed in similar human language. The force of heat is radiated, reflected, and refracted under similar laws to those just stated for light. These simple laws govern the heat which is generated within our systems by the burning of our food, and the heat yielded by our fires and flames, no less than they govern the heat which, radiating in every direction from the sun, necessarily yields a few rays to that speck in space which is so dear to us and which we call Our Earth. Were the laws of heat better understood by the denizens of that planet, they would commit fewer mistakes in the matter of clothing by night and by day, in summer and in winter, fewer in the warming of their public edifices or their private dwellings.

From a consideration of the laws governing the force which penetrates the eye and thus enables man to see—the laws of light—and from an allusion to the laws governing the kindred force which penetrates every part of the skin and affects every part of the animal frame—the laws of heat—it would be appropriate to

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pass to a notice of the laws governing those vibrations of which we become conscious through the ear—the laws of sound. Laws govern the origin of sound, its propagation, its intensity and velocity, its reflection—producing echoes—and even its refraction—for the tick of a watch is better heard at the focus of a gaseous lens than at any adjacent place. Laws too regulate the quality of sound, including pitch, power, and timbre; and regulate chords and discords. One set of laws governs the sounds produced in horns and other tubes open at both ends; another set is at work in the pandæan pipe and other tubes open only at one end; while by still another set do we get sound from gongs and other plates, the triangle and other rods, and the drum and other membranes.

Some of the most interesting and, to man, important of the laws of God in nature govern the production, action, and effect of the food we eat, the fluids we drink, the physic we swallow, and the many materials we similarly change, in furnaces and factories, from one kind of substance to another. The great variety of substances which pass into the systems of man and other animals by the mouth and throat are composed of very few primary or elementary forms of matter. Indeed, probably ninety-nine hundredths of what man swallows, whether as food, drink, or drugs, are composed of four elements only; but these four are endowed with such marvellous powers of combination, and are governed in those combinations by such wonderful laws, that they suffice for almost the whole of man's alimentary needs and the similar needs of the lower animals. The vegetable kingdom too is chiefly built up of the same four elements. They are, in short, the four characteristic organic elements, that is, elements forming the various organs of plants and animals. In childhood and in youth, and in the corresponding periods of the lives of the lower animals, enough of mineral elements must be absorbed from food to produce a framework or skeleton; and throughout the whole of life our animal and vegetable food must contain enough mineral matter—supplemented by a daily portion of the actual mineral termed salt—to produce certain physical effects within us; occasionally, too, some of us have to swallow relatively minute quantities of mineral medicines: but mainly, so far as quantity is concerned, we have to rely for sustenance and for medication on the multitudes of the compounds of four elements—carbon, hydrogen, nitrogen, and oxygen. Now the first great law or decree respecting these four and indeed all other elements is that already alluded to, namely, the wonderful power or character of combination, including intensity and precision of combination. Example.—Reference has

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already been made to the element carbon as familiar in the forms of coke and charcoal, and to the fact that when it is made hot in a fireplace twelve parts of it will combine with thirty-two (*i.e.* 31·92) parts of one of the elements of the air (oxygen), the two producing forty-four (*i.e.* 43·92) parts of carbonic gas. Now such is the wonderful character of this combination that the carbon has lost its blackness, its hardness, its relative heaviness, and, in short, all the properties which enable us to see it and feel it. And such is the intensity of the combination that only by the exercise of the highest skill and at great cost for apparatus and labour can man get back the carbon from the carbonic gas. Such, too, is the precision of the combination that the proportion of carbon to oxygen in the product is always the same. You may vary to some extent the proportions in which, for example, you mix flour and water to produce bread, because here you are only calling to your aid the mechanical force of adhesion or cohesion; but if you bind things together by the force we are now considering—the chemical force—then to produce a given product you are restricted in the proportions of constituents, and all the human skill in the world cannot vary the proportions. Use more than the stated proportion of the one, and the excess will remain behind uncombined; use more than the fixed proportion of the other, and the excess of that also will remain uncombined. Carbon always combines in proportions of 12, that is, 12, twice 12, or thrice 12, and so on; oxygen in proportions of 16; nitrogen, 14; hydrogen, 1; etc. To every element in nature has been given, not by man, a combining proportion, which is fixed and invariable, and in this proportion each element performs the work it has to do. Not more certainly does each of the sixty or seventy notes of a perfectly-tuned instrument of music vibrate at a different rate to the others but in fitting relationship with them all, than does each of the sixty or seventy elements of nature do its work with a power special in kind and fixed in quantity but in perfect harmony with the power of all the others. Let us sum up respecting the laws governing the production, action, and effect of food, and, indeed, governing not only the changes which take place within all vegetables and animals, but governing all similar changes in nature. Law 1.—It has been decreed that the ultimate particles of every one of the comparatively few elements which form all the material things known to us shall have this marvellous power or force or attribute of combination; a power that entirely changes the properties of the element or compound on or in which it is exerted. Law 2.—The proportions in which the elements so combine are

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fixed and invariable as regards any one definite substance. Law 3.—Different substances containing the same element as one component of their structures contain that element in exact multiple proportions. Thus a few elements compose and a very few simple laws govern the composition of all material things, the same laws governing those *changes* in all material things which take place within plants, within animals, within all fires and flames, or which lie at the base of much of the art and most of the manufactures carried on by man.

In the region of art, indeed, human skill occupies so prominent a place that, at the first glance, nature and superhuman law appear to have been left outside. Closer inspection, however, shows that here also nature and nature's laws hold supreme sway. The painter must look to nature for canvas, pigment, and brush; he himself, eye and hand, body and brain, is a grand combination of matter and force governed by superhuman law; while the effects he may produce are dependent on the force and laws of light. Something else no doubt contributes to the production of a work of art—that wonderful *will* which is so suggestive of higher Will. Nature, including her matter, forces, and laws, gives to the sculptor his marble and then guides his arm and his chisel. Gravitation gives to the architect's plummet the whole of its guiding power. Natural law governs the strings of the harp and the violin no less than it governs the vocal cords of the human throat. In the mechanical arts, too, no movement can be effected, no work can be done, that has not the sanction of superhuman laws. Nature and natural law are as active in art as elsewhere; in short, art is for the most part only a phase of nature.

The author's task, or labour of love, is accomplished. The matter of which the universe is formed has not been considered in this Address, or only incidentally. That energy in nature which in our imperfect human language we regard as force, or as a system of correlated forces, has only been cursorily considered, while the chief subject of the Address, namely, the laws and leading attributes of matter and of force, is so great and grand a subject that the time and power at disposal have barely sufficed, but perhaps have just sufficed, to introduce the subject to those before whom this Address has been delivered. To comprehend the beginning or the end of nature would seem to be impossible to man, at all events as he is at present constituted; but to understand very much respecting the materials and the energies of nature and the laws by which all nature is governed is both possible and practicable. We know far far more of nature than was known a single century ago,

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we can foresee many things that will sooner or later be known to patient earnest skilful seekers after truth, while there is, we may be certain, very much more to be known that we cannot now foresee. The study of what is known of nature is commended to all, but especially to those whose interest in nature is to be inferred from the fact of their membership of a Natural History Society. The means are at hand. Books on every division of the subject are to be had almost for the asking, and the effort of mind and the time required are not necessarily greater than are needed by the majority of persons who more or less master what is termed an accomplishment. Even a partial knowledge of only a few of nature's laws will be found to afford that education which even the best educated are ever desiring, education in principles rather than in isolated facts, education which ever enlarges the mind, dislodging the trivial and the commonplace.

Finally, for treating all laws in nature as the Laws of God in Nature no apology is now offered, for certainly none can be necessary, even though hearers or readers regarded the belief in the divine origin and maintenance of the universe only as a grand generalisation born of the highest human aspirations, or were followers of other religions than that which prevails amongst the members of the Hertfordshire Natural History Society.

The sun, the moon, the stars, the seas, the hills, and the plains—
Are not these, O Soul, the Vision of Him who reigns?
Is not the Vision He? tho' He be not that which He seems?
Dreams are true while they last, and do we not live in dreams?
Earth, these solid stars, this weight of body and limb,
Are they not sign and symbol of thy division from Him?
Dark is the world to thee: thyself art the reason why;
For is He not all but thou, that hast power to feel "I am I"?
Glory about thee, without thee; and thou fulfillest thy doom,
Making Him broken gleams, and a stifled splendour and gloom.
Speak to Him thou, for He hears, and Spirit with Spirit can meet—
Closer is He than breathing, and nearer than hands and feet.
God is law, say the wise; O Soul, and let us rejoice,
For if He thunder by law the thunder is yet His voice.
Law is God, say some: no God at all, says the fool;
For all we have power to see is a straight staff bent in a pool;
And the ear of man cannot hear, and the eye of man cannot see;
But if we could see and hear, this Vision—were it not He?

—*Tennyson.*

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II.

THE GREAT ESSEX EARTHQUAKE OF THE 22ND OF APRIL, 1884.

By Professor R. Meldola, F.R.A.S., F.I.C., F.C.S.

A Lecture delivered at Hertford, 11th December, 1885.

Abstract communicated by J. Hopkinson, F.L.S., F.G.S.

PLATE I.

It will be in the recollection of the members of the Hertfordshire Natural History Society that on the 22nd of April, 1884, we had what for this country may be considered a very serious earthquake. The centre of that disturbance happened to be in the county of Essex, and it being highly desirable that such a visitation should not be allowed to pass without being thoroughly investigated by the chief if not the only scientific society in Essex (the Essex Field Club), I undertook, in conjunction with Mr. William White, one of the members, to draw up a report upon it. The result of our investigations is contained in a book of 230 pages, with 4 plates and numerous other illustrations, which is on the eve of being published; * and my lecture this evening will consist of the pith of that report.

Our reason for undertaking the work was because we considered it just the kind of work which ought to be done by local societies, and not because we possessed any special knowledge of the imperfectly-understood science of seismology, and the first thing we found it necessary to do was to find what records existed of previous British earthquakes which would at all compare with this one. At first we contemplated giving a complete chronological catalogue of all the earthquakes that have been recorded in Britain; but, for reasons which I need not now stop to explain, after drawing up a list as the result of a considerable amount of literary research, we had to abandon our intention and to limit our catalogue to such earthquakes as have caused structural damage in this country.

It is very difficult to say whether the early earthquakes were as serious as they are reported to have been; for, with all respect to the early chroniclers, there can be no doubt but that they were inclined to "draw the long bow." For instance, I may quote the record published by Dr. Short of an earthquake in Somersetshire in A.D. 103, which says that "a city was swallowed up name and all," and if that were true it must have been a very serious earthquake indeed. Again, in A.D. 132, there is said to have been one in the West of Scotland, when "men and cattle were swallowed up"; another in 204, when "a city in Brecknockshire was swallowed up"; and in 261 "a terrible one in Cumberland." But such accounts as these have to be taken *cum grano*; and, after fairly considering all the records we have got together, I think it can be said

* This work, entitled 'Report on the East Anglian Earthquake of April 22nd, 1884,' has recently been published by Macmillan and Co.—Ed.

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that there have been only about six earthquakes in this country since the twelfth century which can compare in intensity with the recent Essex earthquake. These are as follows:—One in April, 1185, recorded by a great many chroniclers, as affecting all England, but especially Lincoln, where the cathedral and many other buildings were thrown down. Holinshed speaks of this one as "a sore earthquake . . . . such a one as the like had not been heard of in England since the beginning of the world." One in 1246, which did a great deal of damage in Kent, where several churches are said to have been "overturned." One in 1248, in the West of England, when part of the tower of Wells Cathedral is said to have been thrown down, the Cathedral of St. David's partially destroyed, and many churches in Somersetshire damaged. One in 1275, also in the West of England, when many churches are said to have been thrown down, amongst them being St. Michael's, Glastonbury. One in 1382, felt in England, France, Brabant, and Flanders; most violent in England, where several churches are said to have been thrown down in the south-eastern parts. The remaining one, which was felt in Norwich and almost the whole of England, was in 1480, when it is said that many buildings were thrown down and that much damage was done.

Among the earthquakes recorded in the report is one on the 19th of March, 1750, which is stated to have been felt, among other places, at Cheshunt, Hertford, and Ware. It is thus recorded: "Several successive shocks; loud noise like thunder or passing waggon; bells rung in church steeples; chimneys thrown down and houses damaged in London; 'great stones fell from the new spire of Westminster Abbey.'"

The intensity of an earthquake can best be judged by the amount of damage it does; and it is very strange that although the county of Essex can now boast of the most serious earthquake that has occurred in Britain for four centuries, it seems hitherto to have been remarkably free from them. There are only previous records of very slight earthquakes in Essex, and those seem to have been merely the vibrations of more serious ones in other parts of the country. Among the Essex records it is very interesting to find, as we do from the 'Philosophical Transactions of the Royal Society,' that the great earthquake at Lisbon, in 1755, which caused such tremendous destruction of life, and which threw the water in ponds, etc., into a state of agitation nearly all over this country, was noticed at Rochford. The record is headed "Agitation of water in Rochford, Essex, Nov. 1, 1755," and is contained in a letter from the Rev. Mr. Tomlinson to the Rev. Dr. Sykes. This earthquake was also noticed in Hertfordshire. In a paper read before the Royal Society, the Rev. Thomas Rutherford, D.D., F.R.S., described the oscillation of the water in a pond at Patmer Hall, in the parish of Albury, "on the first of November [1755], between ten and eleven o'clock in the forenoon," and stated that it was accompanied by "a rumbling noise, like the wind." Dr. Rutherford adds that at Wickham Hall, in the parish of Bishop Stortford, "a pond was

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moved at the same time in the same manner," and also one at Thaxted in Essex.*

In commencing our investigations on the recent earthquake, we took measures to procure records from persons living in and around the area of destruction, and we received altogether between 300 and 400 such records, besides making ourselves two tours of inspection throughout the area.

The shock was felt over a very wide area, extending on its extreme eastern limit to Ostend; on the west to Street, in Somersetshire; on the south to Freshwater, Isle of Wight; and on the north to Brigg, in Lincolnshire†; the total area affected by the shock amounting in all to at least 50,000 square miles, so that it was certainly an earthquake of very great intensity (see Plate I).

The data necessary for calculating the intensity of the shock with any approach to accuracy can only be obtained by means of appropriate instruments, and as these were wholly wanting in the present instance, we could only estimate the intensity, as compared with that of other earthquakes, in a very crude way by comparing the relative areas shaken. Comparing the area shaken in this case with that affected by the great Lisbon earthquake, we found that the intensity of the Essex shock was somewhere about one-twentieth of the great Lisbon shock in 1755.

One interesting feature of the disturbance was that it occurred during a period of general seismic activity throughout the world.‡ We have given in the report a list of the earthquakes which occurred during the three years preceding this shock, and during that time there were some of the most violent of modern seismic catastrophes. For instance, in 1881 there were the great earthquakes in the Azores, in Ischia, and in the Island of Chios; in 1883 there was another great earthquake in Ischia; and about the same time there was the great eruption in the Sunda Straits, which was certainly one of the most stupendous volcanic eruptions of modern times.

With regard to the meteorological conditions which accompanied the Essex earthquake, there has always been a tendency among the populace to associate visitations of this kind with some extraordinary atmospheric phenomena, which they were ready to connect in some mysterious way with the earthquake; and to show how the love of the marvellous still lingers among some people, I may mention that one observer at Tillingham sent in a report saying that immediately after the shock had passed "a sulphureous vapour was noticed to arise," but I do not think it likely that anything of the

* See Cussans, 'Hist. Herts,' Edwinstree Hundred, p. 164.

† See p. 32 as to its effects at Leeds, still further north.

‡ In connection with this feature it may be of interest to mention two earthquakes which have recently been felt in Hertfordshire. One which occurred on the 28th of February, 1878, in the south of England, was felt at St. Albans, as recorded in 'Trans. Watford Nat. Hist. Soc.,' Vol. II, p. 215; and the other, which occurred on the 20th of January this year (1886), in the west of England, caused a slight oscillatory movement at Hertford, and a notice of it will be communicated to the Society by Dr. Shelly.—ED.

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kind occurred; this "sulphureous vapour" must have arisen out of his inner consciousness. As far as my inquiries have gone, I do not think any connection can be shown between any such natural phenomena and earthquakes, and in this instance at all events there is nothing to show that the disturbance was accompanied by any remarkable atmospheric movements.

Japan (which is very favourably situated for the purpose) is the only country in the world where the science of seismology is being systematically and practically carried out, with the aid of very efficient instruments, by which it is possible to make very accurate observations. It had always been supposed hitherto, on the assumption of Mallet, that an earthquake was simply a wave of elastic compression passing through the materials of the earth's crust, and causing the particles at the surface to oscillate to and fro in a closed curve, the amplitude and period depending upon the intensity of the originating impulse. Nearly all the calculations formerly made with respect to the maximum velocity of displacement as deduced from the projection of bodies were based on the supposition that the movement at the surface was of the nature of a sudden jerk; but these have been pointed out by Professors Ewing and Milne to be devoid of value. The old view of earthquake-motion might hold good in the case of an instantaneous impulse originating at a point in a homogeneous solid of uniform elasticity in all directions, but such conditions are never realised in actual earthquakes. In the first place, the disturbance never originates at a mere point, but always along an axis of greater or less extent, such as a fissure or fault. The vibrations thus set up, in travelling to the surface, undergo so many changes of direction by reflection and refraction in passing through the very heterogeneous materials of which the earth's crust is composed, that the motion of a particle at the surface is, in all cases where the movement has been traced by seismographs, of an extraordinary degree of complexity. Professor Ewing, who has had the opportunity of recording a large number of earthquakes in the Plain of Yedo, in Japan, summarises his results as follows:—

"Automatic records given by seismographs confirm what has been said, on theoretical grounds, as to the complexity which earthquake-motions may be expected to present. They show that, as observed at a station on the surface of the earth, an earthquake consists of a very large number of successive vibrations —in some cases as many as three hundred have been distinctly registered. These are irregular both in period and amplitude, and the amplitude does not exceed a few millimetres, even when the earthquake is of sufficient severity to throw down chimneys and crack walls; while in many instances the greatest motion is no more than a fraction of a millimetre. The periods of the principal motions are usually from half a second to a second, but, as has been already said, the early part of the disturbance often contains vibrations of much greater frequency. The earthquake generally begins and always ends very gradually, and it is a noteworthy

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fact that there is in general no one motion standing out from the rest as greatly larger than those which precede and follow it. The direction of motion varies irregularly during the disturbance—so much so that in a protracted shock the horizontal movements at a single station occur in all possible azimuths. The duration, that is to say the time during which the shaking lasts at any one point, is rarely less than one minute, often two or three, and in one case in the writer's experience was as much as twelve minutes."

After examining the effects of the Essex earthquake on buildings and carefully considering the records sent in, I have come to the conclusion that it differed in no respect from the shocks experienced in Japan. I believe it commenced with a series of small vibrations which gradually increased in amplitude until the shock came, and then gradually diminished. I may mention the case of an observer at Heybridge who was sitting in his office, on the wall of which a T-square was hanging on a nail. He happened to be watching it, when to his surprise he saw the T-square moving slowly to and fro, and while he was wondering what caused it, the shock arrived. It was afterwards found that the plane of the wall on which the T-square hung was in the direction that the disturbance would travel, so that in fact the whole building was moving slowly to and fro before the shock arrived; and this tended to show that the movement began gradually, like the Japan earthquakes. The records received are very untrustworthy for determining how long the shaking lasted, and also the number of shocks felt (as few people were able to discriminate between the number of shocks and the number of vibrations), but after carefully considering the evidence received, I came to the conclusion that the shaking lasted from two to thirty seconds, and also that it was pretty certain that there were at least two distinct series of vibrations separated by a short interval. With regard to the damage caused by the earthquake, of which a detailed account is given in the report, I may mention that in twenty-four parishes (besides Colchester) the number of buildings damaged was 1213, in addition to 20 churches and 11 chapels. The main damage occurred along an axis about five miles in length, extending from Wivenhoe to Peldon, and comprising an area of between 50 and 60 square miles, within which there is hardly a building that was not damaged in some way or other. Round about Peldon and Abberton there is not a single cottage that did not receive damage, and the solid masonry of some of the houses was rent and fractured in such a way as to show that that was the centre of activity. Then at Wivenhoe again the damage done was very great, though it was much less in the intervening district, and it is a curious feature that although the damage was so great at Wivenhoe, it fell off very suddenly and abruptly. Perhaps the building which sustained the most injury is the church at Langenhoe, which was a complete wreck.

A complete analysis is given in the report of all the evidence received relating to the earthquake, not only in Essex, but also from many other parts of England.

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The records from Hertfordshire, which may be of interest to members of this Society, are as follows:*—

Ashwell, near Baldock.—Shock felt at "The Bury" by Mr. E. King Fordham.

Barley, near Royston.—Shock felt slightly but distinctly at about 9·20; chiefly on the south side of the village on the high ground.

Bishop's Stortford.—Oscillation distinctly felt in many buildings, house-bells rung and furniture disturbed; time about 9·21 (?).

[*Buntingford.*—In an upstairs room of a house in the town a sound noticed as of some one walking across the room, and causing the glasses, etc., on the washstand to jar. Reported by the Rev. C. W. Harvey.†]

Cheshunt.—Shock felt and a bell rung at "Arlesdene," the residence of Mr. H. C. Wales. [Mr. Wales says: "My personal experience of the shock left a very palpable record on my memory. Being ill at the time, and lying on my back in bed, at about 9·20 a.m., I felt a distinct movement as if the bed were being lifted; attended instantly with the ringing of the bell connected with my room, which being answered by a servant, I asked if there had been any movement of large furniture, or if anything had happened in the house to account for what had occurred. Receiving a negative answer, I expressed a fear that we should hear that some terrible explosion had taken place at the Waltham Powder Mills, two miles and a half distant."]

Hertford.—Shock felt slightly in some buildings. [Dr. C. E. Shelly reports: "The earthquake was distinctly felt in the upper rooms of a house in Fore Street, as two separate shocks succeeded by a much fainter third shock: the vibratory character of the motion was remarkable, producing a slight nauseating effect like that of sea-sickness, and recognised at the time, about 9·20 a.m., as being probably due to an earthquake. The shock was not noticed on the ground-floor. It was also felt in two houses at Hertford Heath, and in Haileybury College—in the upper rooms only. In one case the bed was felt to sway, loose crockery rattled, and a wardrobe door was swung open." Mr. V. Austin adds: "The shock was felt at the 'Hertfordshire Mercury' office, particularly on the fourth floor, where the employés, who attributed the oscillation of the building to an explosion at the Gunpowder Works at Waltham Abbey or elsewhere, were much alarmed. The shock was also felt at Messrs. Neale and Sons' in Fore Street, and in two or three private houses, and very distinctly at Mr. Gilbertson's house near the top of Mangrove Lane, where a bed and its furniture were very perceptibly shaken."]

King's Langley.—Shock distinctly felt at "Langleybury," the residence of the late Mr. W. Jones Loyd; in a bedroom, china and movable articles rattled, the bed-curtains shook, and the oscillation

* The records within brackets are additions to the original report, and, except those from Buntingford and Throcking, are the result of enquiries I have made since this lecture was delivered.—Ed.

† In 'Trans. Herts Nat. Hist. Soc.,' Vol. III, p. 246.

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of a chair was felt by a person seated on it; time 9·20. Reported by Mr. Loyd.

St. Albans.—Shock felt but slightly, and chiefly by persons in bed; no pictures nor furniture displaced. [Mr. A. E. Gibbs reports: "The earthquake was felt by persons in bed in St. Peter's Street, the Market Place, and Worley Road. In a house in Verulam Road the shock was felt, and at the time a flower-pot was noticed to shift slightly from its position. At the Gas Works, although the shock was not actually felt by any one, it made itself manifest by the rattling (described as 'violent') of some metal-work over the door of the counting-house."]

[*Throcking.*—A rumbling sound heard at about 9 a.m. (?) imagined to be thunder. Reported by the Rev. C. W. Harvey.*]

Tring.—Rumbling noise heard at a mill on the Icknield Way, near Tring. Reported by the Rev. F. W. Ragg.†

Ware.—Very slight shock probably felt.

I have endeavoured to ascertain how long the shock took to travel, and, taking the most trustworthy records as to time, I have come to the conclusion that the mean velocity of transmission was between 9000 and 10,000 feet per second, or nearly 7000 miles an hour, which agrees fairly well with the observations of earthquakes taken in Japan and elsewhere.

* *Loc. cit.*

† The following letter from the Rev. F. W. Ragg, of Marsworth Vicarage, in Bucks, but just on the borders of Herts, and two miles north of Tring, appeared in 'Nature' of the 8th of May, 1884:—

"This village (Marsworth) lies partly on the lowest beds of the Chalk, and partly on the Gault; it is between N. lat 51° 49′ and 51° 50′, and W. long. 0° 40′ and 0° 41′. The shock was felt at the church, and at two cottages where invalids were in bed. The church is on rising ground at the edge of the chalk platform which lies between the Chilterns, some two miles away from them. I was on the scaffolding erected for repairs to the church. At a little past nine—it could hardly have been later, I think, than 9·15, if so late—I felt the church give what seemed a fierce shudder. This seemed to begin on the east, rather to north, and travelled westwards nearly. By shudder, I mean that a sort of vibration began which almost instantly increased in intensity, reached a climax, and then rapidly decreased and died away. It seemed to me to begin slightly north of east, because I remember feeling (for what reason I can hardly say) that the cause was hidden from me behind the east end of the church. I was on the south side, some eighteen feet from the south-east corner. A moment afterwards a whirlwind followed, which began, as I find, near the top of the slope north-east of the church, and followed the churchyard wall which bends round the churchyard to south-west. In a cottage on the junction of the Chalk and Gault (or very near the junction), according to the result of inquiries I have made of an invalid there, the pictures on a wall lying north-west and south-east moved from and to the wall, but seemed also to move along it somewhat, *i.e.* north-west and south-east. Flower pots on a table rocked in a direction almost east to west, and a window facing the south-east shook; her bed also, lying north-west and south-east, waved, and seemed as if giving way. This took place, she says, a little after nine. In a cottage on the Gault, where another invalid was lying, a window facing south-west rattled, a picture shook on the wall on which it is fixed, and the bed, lying south-east and north-west, also waved. This was she thought at nine, but the time must have been later. She noticed that the wind was still. No noise was heard except the clatter caused by the rattling of the buildings; but at a mill on the Icknield Way, near Tring, lying at nearly lat. 51° 48′ and long. 0° 48′, a rumbling was heard."

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In trying to find out the origin of the shock, that is, the point where it happened, the evidence leads me to believe that it probably originated somewhere beneath the villages of Abberton and Peldon, and that it apparently suffered a considerable amount of reflection at Wivenhoe.

One very common form of damage which we constantly observed, was the peculiar twist given to chimneys, which were not thrown down, but broken right across and the upper part twisted round; but whatever its explanation may be, I think it perfectly conclusive that we could not arrive at the direction in which the earthquake travelled by the direction in which the chimneys were twisted.

[On considering the damage done by the earthquake in relation to the geological structure of the area affected, it will be evident to geologists that there is no marked difference in hardness and elasticity in the surface-formations of this area. The whole area of damage is on the London Clay, covered here and there with occasional patches of drift sands or gravels and alluvium. It seemed likely that the vibrations would produce a greater effect upon buildings situated on a damp coherent formation like clay than upon those on loose gravel, and we were not surprised, therefore, to find that at Colchester many of the residents had formed the opinion that the chief damage was confined to the clay areas. A certain amount of damage, however, occurred on the drift and alluvium, and we believe that the greater destruction occurring on the clay was not due to the dynamical effect produced by the difference between clay and drift, but was a pure geological accident, due to the fact that the initial blow was given beneath the London Clay in the Peldon-Abberton district.

The lines of junction of different geological formations probably had some effect upon the earthquake-wave, and free margins, such as coast-lines, river-valleys, and lines of outcrop, certainly had. When an earthquake-wave passes from one formation to another of different elasticity, a portion of the wave is reflected at the surface bounding the two formations, and the remainder is refracted in accordance with the laws of wave-motion. The shock thus tends to become exaggerated along such boundaries, owing to the interference of direct and reflected waves, giving rise to what we have termed "junctional vibrations." In this instance those portions of Colchester, and also of Rowhedge and West Mersea, most severely visited, are situated near the junction of clay with drift-sand or gravel; but at the more distant stations junctional vibrations cannot be clearly traced to have had any effect, for there is no preponderance of records from the various towns and villages situated along the junction of the Tertiaries with the Chalk either north or south of the London Basin.

Along free margins there is no resistance offered, in one direction, to the vibrating particles in their outward movement. This may be illustrated by placing a row of marbles in contact with each other and delivering a blow at one end of the series, which will cause the last marble at the other end to move outwards. "Marginal

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vibrations" are thus produced; and in the present earthquake the shock was probably felt at many stations on account of their marginal situation. Thus at Maldon the shock seemed to follow the river Blackwater, and in London it was especially distinct at various places along the Thames. In the area of structural damage the alluvial flats and marshes slope too gradually to the sea for effects due to marginal vibrations on the coast-line to be observed; but the numerous records from places round the south and east coasts are suggestive of the movement having been exaggerated at these stations on account of their marginal situation. There is also a certain preponderance of stations at which the shock was felt situated along lines of outcrop, and more especially along the escarpments of the Cretaceous series, which favours the view that these places were shaken by marginal vibrations, reinforced possibly at some places by junctional vibrations. No certain connection has been traced between lines of faulting and the distribution of the shock.

The velocity of propagation of earthquake-movement depending upon the elasticity of the rock-material, geologists naturally called attention to the older, harder, and more elastic rocks which underlie the newer and softer formations of this country; and I think that it may be safely concluded that the westward extension of the shock was as it were exaggerated by the spreading of the older rocks in this direction; but the connection is not very clearly defined. Towards the western limits of the shock the older rocks come near to, or actually crop out at, the surface, and towards these limits there is a large preponderance of records from the older geological districts, and moreover the action of the older rocks in spreading the shock is apparently shown by all the extreme stations being either on Palæozoic formations or very near their outcrops.*]

Some very curious effects of the earthquake upon underground waters may now be mentioned. At Colchester, for instance, which is pretty near the centre of the disturbance, the supply of water in the deep wells sunk into the Chalk had been falling off for some months previous to the shock, so that it had been decided to deepen them, but after the shock the water rose in them over seven feet, and this increased level was maintained for over six months, after which it commenced to gradually diminish, and it has now got almost down to its former level again. This has been accounted for by Mr. C. E. De Rance, Secretary to the Underground Waters Committee of the British Association, in this way—that the shock caused a widening of the fissures through which the water circulates in its course down to the Lower Chalk, and thus, by an increased flow, gave rise to a general increase of level in these water-bearing beds, from which the wells derive their supply. The gradual return of the water to its old level may indicate that

* The above account of the geological aspects of the earthquake I have condensed from the author's complete 'Report,' in which the subject is very fully treated in all its bearings.—ED.

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the widened fissures are being filled up by the infiltration of solid matter, or that they are closing up by the slow settlement of the disturbed strata. At St. Peter's Well, Mersea Island (a surface-well), the effect of the shock was to throw the water bodily out of the cistern, and for some hours afterwards the water ran in a turbid state. A very striking illustration of the wide extent of the subterranean disturbance is furnished from Canterbury, where on the morning of the shock the water from the Artesian borings 600 feet deep, which is always bright and clear, came up in such a turbid state that some of the tanks had to be emptied in consequence.

In conclusion, I may mention two very interesting records which have only recently come to hand. One is from Leeds, 170 miles away from the centre of activity, where the shock was recorded on the tracing-paper of a self-registering barometer, the indentations on which indicated that the shaking lasted for about four hours after the initial shock, although the movement was too slight to be perceived by any one. The other record is from Crowborough in the Weald of Sussex, where a large equatorial telescope in Mr. Prince's observatory, weighing about one ton, was displaced by the shock.

The subject is surrounded by very great difficulties, and, being scarcely studied at all in this country, the observations taken upon this occasion have necessarily been of a rough and ready character, and have given my colleague and myself no small amount of trouble to sift; but nevertheless it has afforded me great pleasure to lay the principal results of our investigations before the members of the Hertfordshire Natural History Society.

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III.

ON *MELICERTA RINGENS*: A CHAPTER FROM THE GREAT BOOK OF NATURE AS REVEALED BY THE MICROSCOPE.

By JOHN BADCOCK, F.R.M.S.

Read at Watford, 15th December, 1885.

Communicated by F. G. LLOYD, Hon. Sec.

[HAVING reviewed several methods of reading the Great Book of Nature, Mr. Badcock dwelt briefly on the several forms of the Vorticellina exhibited under microscopes in the room, as showing how Nature in her simplest organisms often displays the greatest beauty. Finally he confined his remarks to *Melicerta ringens*, giving the following account of certain of its characteristics.]

Under one of the microscopes may be seen a very interesting animal, and I must ask you to bear in mind its *size*, for otherwise you might think that I was describing a large creature. *Melicerta ringens*, as this animal is called, is only about one-tenth of an inch in length; at present you see only its head or trochal crown as it is protruded from its dwelling-place. It has not always had a house of its own, for when young it left the parental abode and wandered hither and thither through its watery world. Its eyes were then well developed, and no doubt it made the most of them in its wanderings. It was not then very much like its parents, and it had some experience to learn before life with it commenced in earnest. After a while, its roving life is ended, the parental likeness is developed, and our tiny acquaintance rests on some plant or filament of vegetable growth, and, unfolding its now developed crown, begins that work which may end only with its death. A filmy secretion envelopes its tender body, and on it are placed the little bricks which form its wonderful dwelling. The first bricks are placed in a ring around the middle of its body on this enveloping membrane, to which they adhere. Then brick after brick is made and ring on ring is formed, and, being cemented together, they are jerked downwards until the lower ring touches the plant on which the Melicertan is perched. This ring is then cemented to the plant, while the upper rings are still being built higher and higher. Our friend is now securely ensconced in a tower of its own construction, in which it moves with perfect freedom, now coming forth and again withdrawing itself at its pleasure. You see it under the microscope spreading out its four-lobed trochal disc, collecting food and building-material, a wondrously beautiful object. But just tap the table, and instantly it vanishes. After a few minutes, when the alarm has subsided, you see it thrust forth its antennæ as if to ascertain that there is no danger near, and, being satisfied on this point, you observe a gentle quivering on the margin of the tower, and then the full expansion of the crown as before.

Let us examine this creature more minutely. Place it in a smaller drop of water, under the slightest pressure, and bring to bear on it a

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greater magnifying power. It is attached to a branch of *Nitella* or a filament of an Alga. The water is just a drop—hardly that. Yet, if not injured, it still maintains its ordinary occupation—still works and feeds. By and bye you exert a little more pressure—the house is injured, and our friend, more alarmed than usual, makes its escape. Its term of life is soon to end, as it becomes quite helpless out of its house; so a little more pressure may be exerted in order that its mechanism may be more fully seen and understood.

Examining the *Melicerta* with a tolerably high power, and under pressure, our attention is attracted by the apparent rushing of divergent streams through a very complicated piece of machinery, and very careful observation becomes necessary if we would follow these streams to their several destinations.

Let us try to understand them, and in order to do this we must get some idea of the mechanism now at work. There are the four expanded lobes or petals, on the margins of which is a continuous double-grooved row of fine hairs—a collecting apparatus, which, when set in motion, resembles a continuous or endless chain, and this is the most striking and beautiful characteristic of the animal. The cilia, vibrating with quivering life, lash the water in opposite directions, and gather up the floating decomposing vegetable matter in a whirling current, which they then pass along the chase or groove on to the mouth and sorting organs. The streams are here united, but only to be subjected to a thorough but rapid investigation, which results in their being again divided, and this time into three streams or currents. That which is good for food is selected and flows onwards to the mastax, there to be ground down by the action of the teeth into a finely-triturated material for the nourishment of the body; another stream flows off with building-material to the pellet-organ or pug-mill for the making of bricks; and the refuse is swept off with vigour at a tangent out into the open water. Thus five or six streams or currents are going on at the same time—all separate and distinct; for the inward currents are not stopped while the subsequent division which separates them is going on, and at the same time the creature is feeding, making bricks, and building up its habitation. At intervals it has to get rid of effete matter, which involves another action apparently requiring more than ordinary calculation or volition. I shall have presently to revert more particularly to this; meanwhile let us examine more minutely the several organs concerned in the other operations.

We have got thus far a pretty clear idea of the rushing and apparently opposing currents which at first sight seemed so confusing, and now let us follow them one by one. When their division takes place, one current is carried aside to the pug-mill laden with material for brick-making. This may be demonstrated, but not very easily, by placing a little carmine or other non-deleterious colouring substance in the water, when it will readily be accepted apparently both as food and also as a new material for bricks; and we may possibly be able to trace it as some portion

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is finally carried into the pellet-organ. In this way variously-coloured bricks are built up into the dwelling-house of the Melicertan, which make it quite an ornamental structure. There is a good deal of ingenuity required in the making of these bricks, and in depositing them in regular rows. There is a right and wrong way of doing this, and not every Melicertan is an adept in the operation, as every observer who has made himself familiar with them must have seen. We get some very badly-built houses as well as some most exquisitely-constructed ones. The bricks themselves must be properly constructed in order to make a perfectly symmetrical building. In shape they should be something like "minie" rifle bullets, tapering at one extremity, and this is accomplished in this way. When the building-material gets into the pug-mill, it is whirled round and round into a spherical form, and grows larger and denser by the addition of ever-increasing particles, which, being mixed with a secretion from the animal itself, in two or three minutes attain a certain consistency ready for moulding into the required form. This is accomplished by the rolling ball being pushed forward into the mouth of the mill and there being thinned out at one end, on which it receives no more additional matter. The other part meanwhile gradually gets larger, until it attains the required size for its place in the building. It is not always, however, that circumstances allow of the pellet being made in this way. Sometimes it lies right across the cup, that is to say, it has up to a certain point been made the wrong way, rolled, as you would roll a piece of clay in your hands, but out of the proper line. How is it to be altered in order that the proper form may be obtained and its exit secured? This is done by the *Melicerta* stopping the supply of material on one side and then setting up a uniform revolving motion round a horizontal axis, perpendicularly to its ordinary method. Thus the brick is got over to the side where the supply of material is stopped, and is increased in size only on that side where the building-material is coming in, and so the required figure is arrived at.

In the process of building, the bulging outline of the pellet must always be on the outside of the case, and the creature lays hold of it by means of what some observers have called its nose and chin, and pinches it up and carries it away to its right place in an instant. This is done so quickly that you cannot follow the movement, and the animal is back and again at work on another brick before you have recovered your breath, which one may imagine had been for the moment suspended in astonishment.

Let us turn now from the nose and chin, and the pug-mill, to the main current conveying the assorted nutriment onwards to the mastax. Before, however, it is allowed to enter there, it has to pass another sorting or tasting process, and if anything has escaped the first ordeal that is unsuited for food, it is here arrested and thrust upwards and out with the waste. Thus the finest selection is made for that which is to nourish one of the finest and most complicated and most delicate organisms that nature has produced.

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But first of all it has to undergo another process. There are two jaws each with three horny arches armed with transverse teeth. Two of these are turned inwards and the third outwards. To the under arch are attached the muscles of the jaws which move the other two arches, and which thus enable the teeth to work against each other, crushing the food between their strong horny plates and mixing it with the digestive secretion. The oblong stomach and alimentary canal are close by, ready to receive and convert to its proper use the material so elaborately prepared.

With regard to the selection and assortment of food and building-material, I have been astonished more and more the longer and more minute my observation has been. The process is best seen when colouring material is used, for then one sees what is rejected and what is retained for use. By far the greater part of the material collected is rejected as waste, and only the finest and most minute particles are finally accepted. So much is this the case that, when using carmine, I have often been in doubt whether any particles are carried into the pug-mill until they have first passed the digestive process and given their colour to the secretion which then would naturally colour the bricks. But the same remarks would apply to the portion selected as food, for you cannot see it taken down the mouth; and yet it *is* so taken, for the stomach or intestine soon gets full of it. The explanation probably is that the rapidity with which it is done, combined with the fineness of the particles selected, deceives the eye in both cases. Closer examination seems to confirm this view, and there is this further to be said; the carmine is undoubtedly taken into the mastax and passed on to the digestive apparatus, and from its intense colour one would be inclined to infer that it would somewhat colour the tissues of the body if it were assimilated, but no such colouring is seen. The secretions only are coloured. Moreover, from the fact that the colouring matter is abundantly seen in the alimentary canal, we must infer that the creature has accepted it or some portions of it as food as well as for building-material, as otherwise it would have passed to the pug-mill only. But I confess I am in some doubt whether it does not pass on, in the first instance, to the mastax, and thence to the upper part of the alimentary canal, and there get mixed with a viscid secretion to be then passed up to the mill; otherwise we are driven to the conclusion that the same material is sometimes used both as food and for building—unless indeed there is any difference in the component parts of the carmine which only such a creature can detect and separate. And this in fact seems to be the only conclusion we can arrive at. If so, we have here another illustration of the wonderful intelligence or instinct with which the creature is endowed.

It is not, however, by mere inferences that we arrive at the idea of intelligence. A nervous system has been observed in the *Melicerta*. This has been doubted by some and denied by others, but is now generally admitted. Without going deeply into this question, we may try what can be seen and then consider what in-

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ferences suggest themselves. Let us look again at the trochal disc. Two of the lobes are larger than the others, and, when examined very closely, two ruby-like points, very fine and brilliant, are seen in connection with them. It is very generally said in books that although the Melicertans have eyes when young, they lose them on attaining to maturity. Now this is a mistake which I have very often demonstrated by showing the eyes in adult specimens. When the *Melicertæ* are *very* young and in their free condition, the eyes are more of the nature of pigment-spots, but subsequently, though less observable, they are not lost, but they become finer and are then liable to be hidden in the folds of the trochal crown in which they seem to be imbedded and to be connected with a network of nerves, with which this trochal crown appears to be permeated. They are best seen in specimens which have not attained full growth, being in that stage when about a quarter or half of the tower is built. The creatures are then in their full vigour, and if in comparatively clear or clean water, display both the case and its inhabitant to the greatest advantage.

The eyes of the *Melicertæ* are indicative of a nervous system. Then there are the two antennæ-like organs, each tipped with its pencil of setæ, which are projected from the crown before the full expansion of the working, feeding, and gathering organs. The precise use or function of these apparently tactile organs is not known, but they have all the characteristics of nervous sensation, and in view of their use, under circumstances in which danger may have been apprehended, we are justified in adducing them in support of the theory of a nervous system.

I will now call your attention to another instance of what seems like intelligence, and to which I have alluded when speaking of the several currents.

The animal living in a case or tower, with only one opening, and that at the top, a peculiar arrangement of the intestinal canal becomes necessary, whereby the effete matter forming the residuum of food, together with the waste or worn-out products of the body, may be discharged. It is therefore bent in upon itself, forming at its extremity a long cloaca, discharging itself near the mouth.

There is no action of this wonderful creature which has so struck me as displaying intelligence as the means it adopts in order to get rid of this excrementitious matter. We can very well understand its action in an open pond—its natural habitat—where there is plenty of water, and where the ejected matter may be easily carried away, but under microscopic observation, confined in a close cell, with only a drop or two of water, the difficulty is immense; for you must consider that the object is to get rid of offensive material, thrust out as it is into a small quantity of water which is kept in a perpetual whirl by the action of the feeding and gathering organs, by which every particle is drawn towards them. This effete matter is thrust out with great velocity; but it cannot go far in so limited a vessel, and it is again and again caught up in the whirling current and carried towards the mouth,

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and you fancy it must eventually be taken in again. But not so; for as often as it comes forward, so often is it thrust back with greater intensity, until the creature, wearied out, apparently, with this incessant repetition, and finding it impossible to go on with its work and feeding unless compelled to take in that which is loathsome, stops altogether and retires, as if in offended dignity, within its citadel. I have spoken with Dr. Hudson about this action of the *Melicerta*, and he confirms my observation, stating that while many other microscopic creatures are not so particular, and do not seem to mind taking in again this form of excreta, yet he has never seen it done by *Melicerta ringens*. Some people think that microscopists are blessed with too lively imaginations, and that they are given to exaggerations in their descriptions and inferences, yet I would ask the most prosaic among my hearers what inference other than that of intelligent selection he would draw from such a fact as the one I have just described. But, says the objector, the animal is so small, so insignificant, that it is impossible to credit it with anything like intelligence. I admit its smallness. It is because of that, that I am here describing it—because of that, that the microscope has been found necessary to see and know it—because of that, that it is so wonderful, exciting our admiration and elevating and enlarging our conceptions of the Divinity which pervades the universe; but I submit that small and great are only relative terms, and that, to other conceivable organisms in the universe, we ourselves may appear to be of microscopic dimensions, —and as to the other objection, that of insignificance, I cannot at all agree with the objector, that the one quality involves the other. Smallness by no means implies insignificance. On the contrary, the greatest and most enduring effects are oftener than otherwise the results of apparently insignificant causes, and this is especially the case with regard to those minute creatures which, from pre-existing materials, have formed by their united and untiring energies no small portion of the solid framework of the great globe which we inhabit.*

* I have to acknowledge my obligation to the writings of other investigators, and especially to Mr. Bedwell's admirable article in the 'Journal of the Royal Microscopical Society,' for December, 1877.

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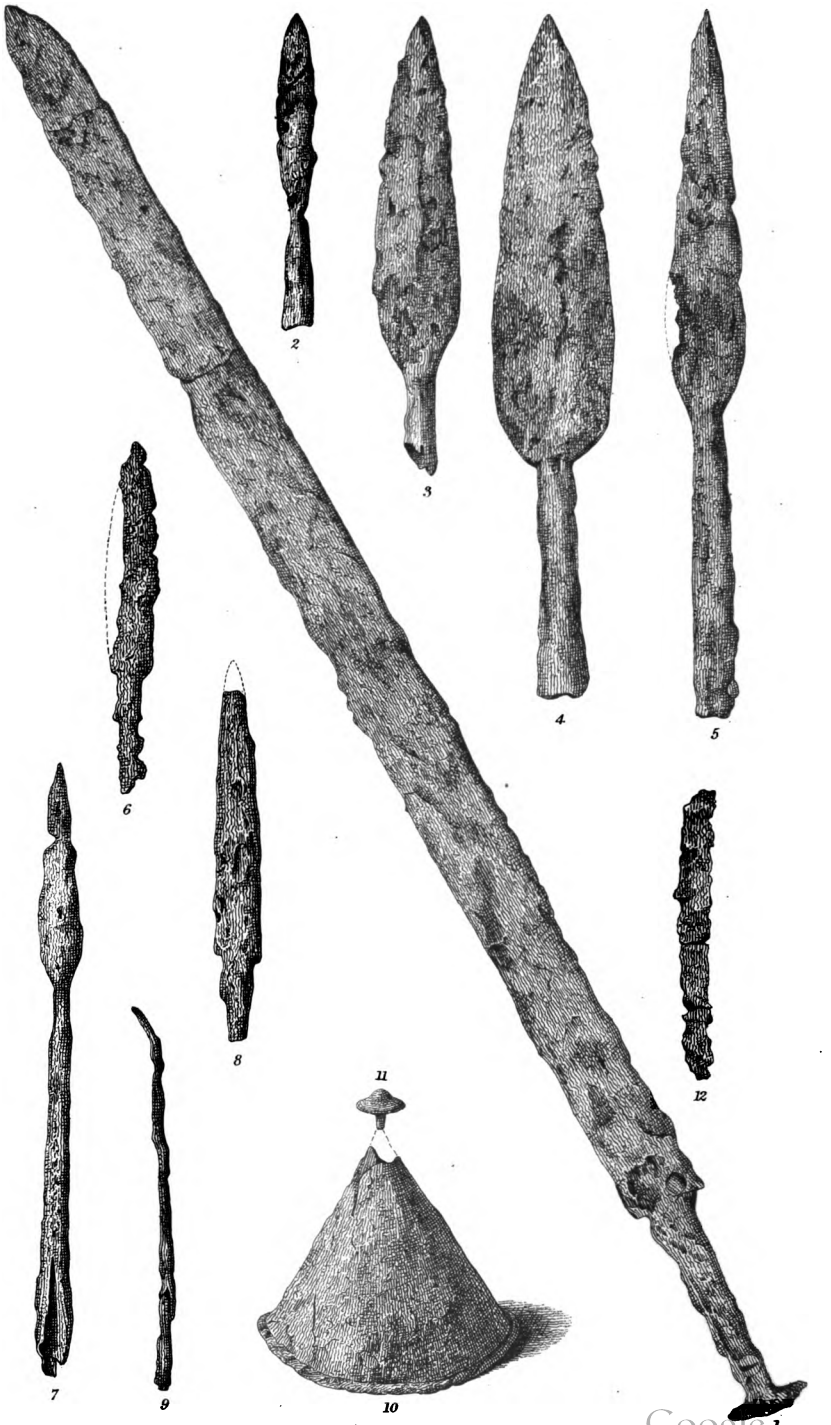

IRON WEAPONS FOUND NEAR ASTWICK.

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IV.

AN ACCOUNT OF BRITISH AND ROMAN REMAINS FOUND IN THE NEIGHBOURHOOD OF HITCHIN.

By William Ransom, F.L.S.

Read at Hertford, 18th March, 1886.

PLATES II-V.

In the spring of 1879 my attention was drawn to a slightly-raised circular plot of ground on Pegsdon Common, at the foot of the Chalk downs, about four miles from Hitchin. I had it opened in company with a friend, Mr. F. Latchmore. Trenches were dug across it, and at a depth of about a foot from the surface we came upon a considerable number of broken urns of brown pottery of the usual type found in Roman burying-places, some of them being in a fair state of preservation, and containing cremated human bones. There were also several pieces of the red ware, formerly called Samian, but now supposed to have been made at Arezzo in Italy, and at other manufactories in France and Germany, while the finest quality only came from the island of Samos. Pliny tells us that Arretum, or Arezzo as it is now called, was famous for its dinner-services, and Surrentum, the present Sorrento, for its cups. In a few cases the Samian ware bore traces of having been mended with rivets of lead or other metal, in the same manner as we were accustomed to repair valuable old china until the discovery of 'diamond cement,' indicating the great value attached to this description of pottery. The brittleness of this ware is frequently referred to by classic writers.

Under these Roman remains, from 2ft. to 2ft. 6ins. in the ground, were a large number of ruder urns of very coarse material, about $\frac{1}{8}$th of an inch in thickness, and extremely friable, so that it was impossible to remove them from the earth without their crumbling to pieces. They were probably British, of an earlier manufacture, and were hand-formed, not turned on a wheel like the Roman ware, and they were probably merely sun-dried, or very slightly baked. Like those above them, they contained human ashes, mixed with pieces of wood and charcoal, and iron nails. These would be gathered up with the bones after the body had been burned on the funeral pyre.

A few feet from this spot was a mound of greater elevation, on digging into which we came upon a perfect human skeleton in a slightly sitting posture. Judging from the unusual length of the bones, the skeleton must have been that of a man not less than 6ft. 4ins. in height, and the skull was of a superior type. An iron knife close by had evidently fallen from his left hand. From his weapon being buried with him, and also from the shape of the skull, I have no doubt but that he was a Saxon, and a man of some note. The Romans did not usually bury their implements of warfare with the dead, whether cremation was practised or not. A special interest attaching to this discovery is, that the three races should

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have chosen the same place for burial, indicating a superstitious feeling connected therewith, and it is a little strange to our ideas to find the ashes of the conquerors resting upon those of the conquered, yet suggesting the happy thought that after death all former difference is at an end. The Icknield Way is about half a mile from this site.

In a field near, known as Dane's field, there were found about forty-five years ago a large number of human skeletons, and also those of horses, with several fragments of iron and bronze. These were probably of more recent date than the cinerary urns found in the cemetery already described. The bodies might have been those of men killed in battle, and hurriedly buried without the usual care bestowed upon an ordinary interment. Within a short distance an almost perfect Roman amphora three feet high has been dug out, and a variety of other vessels have since been found there. It may be interesting to note by the way that the pretty purple *Anemone Pulsatilla*, known as Danes'-blood, grows abundantly on the hill-slopes around, covering the scanty herbage with its purple blossoms in the early spring. It is an object of attraction to our botanical friends far and near.

Three or four miles eastward, near Astwick, in digging for coprolites, a large number of human skeletons were disinterred, and near these were ten Samian vessels, all quite perfect, with the potters' names distinctly legible on most of them. Three of the names had not previously been recorded. The large bowl exhibited, with a raised pattern of fishes, etc., running round it, is an unusually fine specimen of its kind. These vessels are additionally interesting from having the impression of the tips of the maker's fingers, made after he had applied the glaze, distinctly visible underneath each, thus indicating the exact position in which they were held on placing them in the oven to harden. A sword and a number of spear-heads, with divided haft, indicative of Saxon workmanship as distinguished from the usually welded haft of the Roman weapons, were also found. One of these is of a very unusual type. There was also a boss of a shield, which was in fragments, but, when cleaned, the pieces were easily put together.

In 1878 a number of bronze celts were found about two feet below the surface in a field near Cumberlow Green, and with them a quantity of rough metal for casting into implements. They are of similar character to those which are distributed almost all over Europe. They are almost as hard as steel, and they would, with their sharp edge, prove formidable weapons. These are pre-Roman, belonging to a period antecedent to the use of iron in England.

On the 6th of March, 1882, a workman, whilst engaged in draining land near Great Wymondley, a mile and a half east of Hitchin, turned up an earthen vessel of Roman ware. This induced me to make further search, and we soon discovered the first distinct trace that is known of a Roman settlement in that immediate neighbourhood. Within a space of five yards by seven yards were disinterred forty-three cinerary urns of various sizes, shapes, and colours, from

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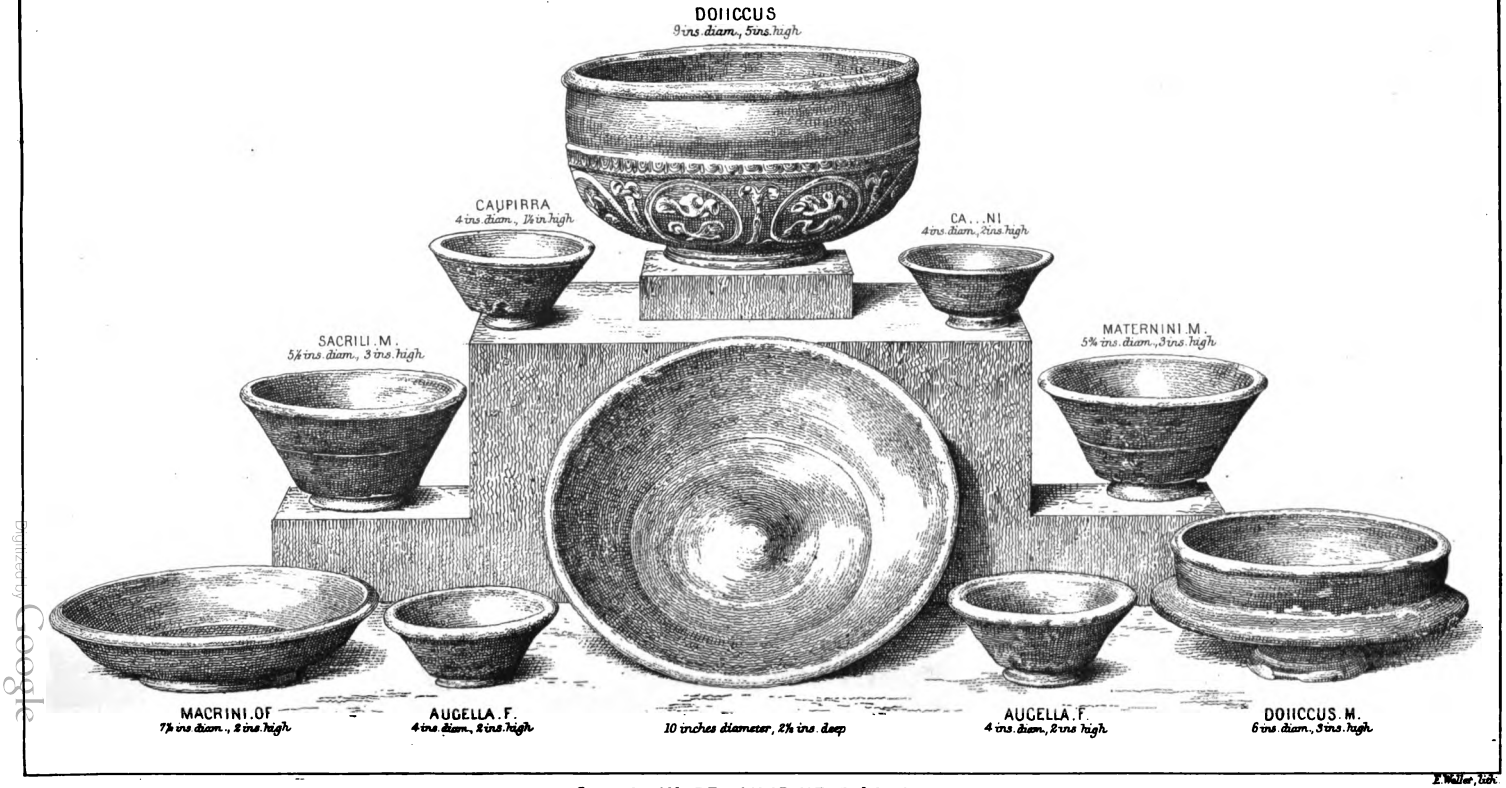

E. Waller, lith.

SAMIAN WARE FOUND NEAR ASTWICK.

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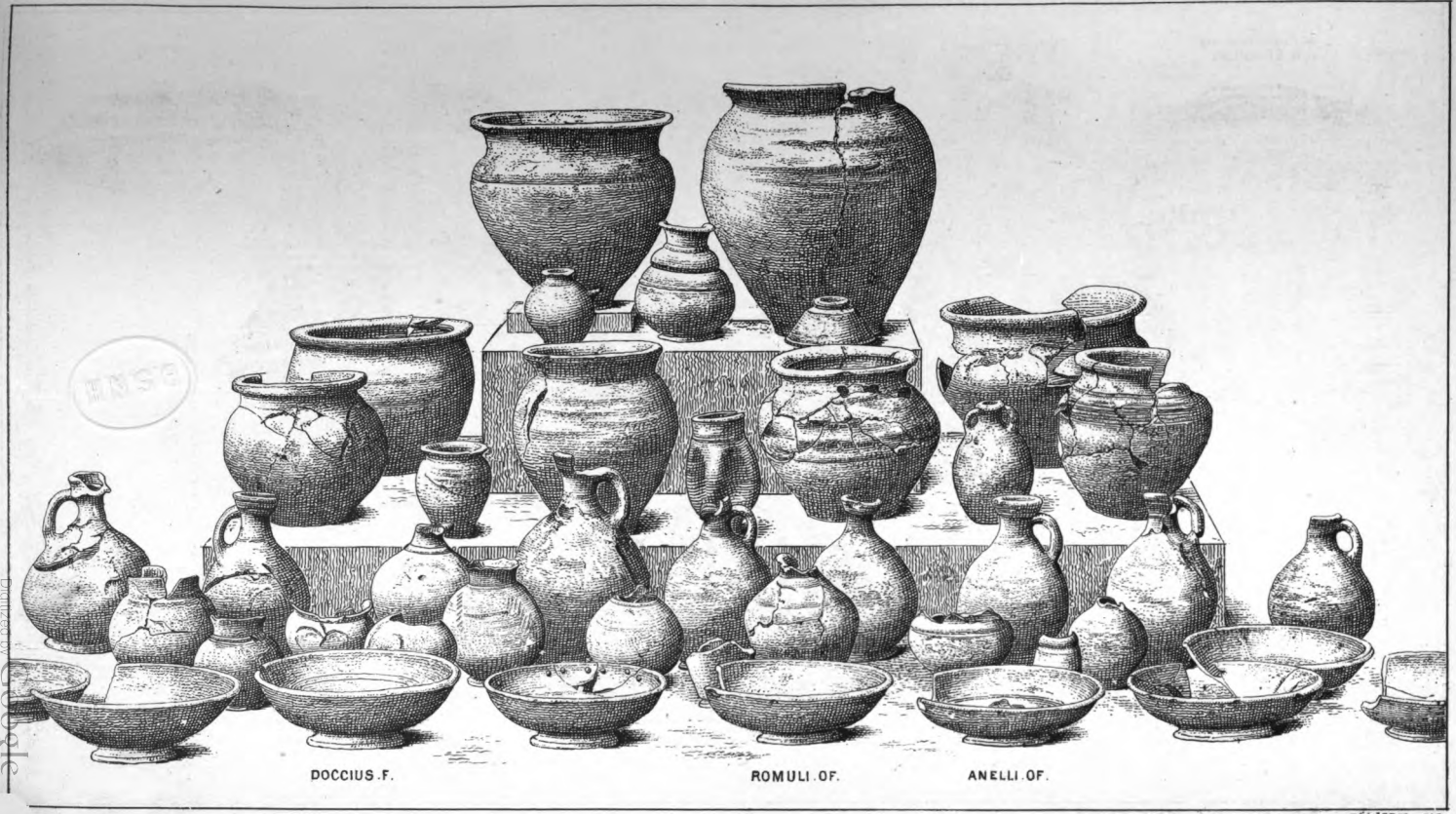

Edwd Weller, lith.

ROMAN POTTERY FOUND AT GREAT WYMONDLEY.

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black to pale yellow, containing burnt human bones, charcoal, and iron nails. Accompanying each urn was a Samian dish and a wine-bottle, some of these being full of liquid, but possessing none of the flavour of the famous Falernian wine. By the side of one of the urns there was a baby's feeding-bottle, thus touchingly indicating that the ashes of a mother and infant rested in the larger vessel, and illustrating the care that was then taken in providing even for the anticipated need of the spirit of the little babe whilst being ferried over the river Styx under Charon's charge. Some of the Samian dishes retained the metallic rivets with which the fractured pieces had been joined, still holding them together. I do not know of any other description of Roman ware that had the same care bestowed in mending it. Of the whole number of vessels, many were so hopelessly crushed that it was useless to attempt to restore them. No two vessels were exactly alike. Several other small vessels—some of elegant shape—which had probably belonged to the departed, were also buried with the urns. Whether the relatives of the deceased were prompted in this by the thought that they might again be used in the spirit-world, or by a superstitious idea in regard to the property of the departed, can only be matter for conjecture. It is easy to recognize much of the pottery, of which we picked out no fewer than forty-five varieties distinct in colour and texture. Several ancient kilns having been found in various parts of England, with the ware still standing on the shelves in the ovens, we are enabled to determine where the different varieties were made. One of the most famous of these was discovered about sixty years since at Castor, in Northamptonshire, the ancient Durobrivæ.* A specimen of this ware was found near Hitchin, with its device in high relief, and similar pieces are constantly found in many parts of England. Hunting-scenes formed a favourite pattern on the better class of the Castor vessels. In connection with pottery I may mention that at Sandy, the ancient Salinæ, an iron implement with serrated edge was dug up, the teeth being alternately set in opposite directions. I was puzzled to understand its use, until, turning out a piece of pottery near, and comparing the indentations upon it, I found that they corresponded exactly with the marks which would be made with the teeth of the implement.

A line of black earth in another part of the field at Wymondley, extending from north to south across it, was perceptible. This was carefully excavated, and it seems to have been a ditch into which all sorts of broken or rejected articles of domestic use were thrown. There were heaps of Samian ware, several pieces of Castor, some of Upchurch, made on the banks of the Medway, and also pieces of New Forest pottery, strainers, and parts of six mortaria, lined with sharp pieces of flint or small pebbles, to facilitate the work of trituration. A strigil, a bent metal implement with which the attendant slaves scraped their masters after leaving the bath,

* The name Durobrivæ is also known as that of a town of the Cantii, the present Rochester.—Ed.

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was also found; and there were many nails and spikes, a key, knives, horse-shoes, some pieces of bronze, and Colchester or probably Richboro' oyster-shells, the contents of which formed a favourite dish with the Romans. In reference to their appreciation of mollusks and crustaceans, Juvenal, in his Fourth Satire, writes of Montanus, a court sycophant, much addicted to the pleasures of the table, that he knew how to discern at the first bite whether an oyster had its birth-place at Circeii or on the Lucrine rocks, or whether it was a native of the Bay of Richborough, and at sight of a crab could tell at once what shore it came from.

We also came upon fragments of Roman glass, pieces of querns or millstones, and volcanic lava. This last I believe to have been used along with the ordinary clay of the district in making common earthen vessels. Analyses of pottery from Pompeii and Rome show it to contain volcanic earth, and favour this suggestion. Hones for sharpening knives, etc., stone weights, and cores from the horns of oxen, believed to be those of the extinct *Bos longifrons*, of which the black Welsh cattle are supposed to be descendants, bones of horses, sheep, and hogs, a large number of knuckle-bones which were used as dice, a quantity of Roman bricks and roofing-tiles of the usual red colour, and some Roman coins, were dug out; these were much defaced by the action of the soil, and their inscriptions rendered illegible. Many coins have been picked up at various times in this field, dating from Vespasian, A.D. 69, to Julianus, A.D. 360, almost continuously. The following is a list of these coins:—

	A.D.		A.D.
Vespasian	69–79	Tetricus	267
Nerva	96–98	Tetricus, Jun.	267–272
2 Antoninus Pius	138–161	Allectus	293–296
Marcus Aurelius	161–180	2 Constantine	306–337
Postumus	258	Crispus	317–326
2 Gallienus	253–268	Constantinus II.	337–340
Salonina, wife of Gallienus.		Julianus	360–363

We next dug in a pasture separated from the other field by a lane. In the south-west corner is a double mound; this we opened, but found nothing more than broken dark pottery and a quantity of burnt earth on a surface which had been beaten down hard. Possibly some sacrifice had been offered there, and the mound four feet in height raised over it. In various parts of this field were lines of stone, about 2ft. deep, running at right angles to one another, probably the foundations of a house, or other buildings, but no mortar was present; this may have perished by the dissolving away of the lime constituent. Fragments of pottery and Samian ware were turned up in almost every part of the quadrangular enclosure, which can be distinctly traced from the raised ground and trenches encircling it, measuring about 20 acres.

Mr. Seebohm, in his book, 'The English Village Community,' thus describes this little Roman holding:—"It consists now of several fields, forming a rough square, with its sides to the four points of the compass, and contains, filling in the corners of the

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square, about 25 Roman jugera—or the 8th of a centuria of 200 jugera—the extent of land often allotted to a retired veteran with a single yoke of oxen. The proof that it was a Roman holding is as follows:—In the corner next to the church are two square fields, still distinctly surrounded by a moat, nearly parallel to which, on the east side, was found a line of black earth full of broken Roman pottery and tiles. Near the church, at the south-west corner of the property, is a double tumulus, which, being close to the church field, may have been an ancient 'toot hill,' or terminal mound. In the extreme opposite corner of the holding was found a Roman cemetery," etc.

Before taking leave of the Wymondley cemetery, these beautiful and touching lines of Horace to his friend Septimus when he points to the spot where he wished his own ashes to be laid, may be appropriately quoted ('Opera,' Lib. ii, Ode 6):—

"Ille te mecum locus et beatæ
Postulant arces; ibi tu calentem
Debita sparges lacrima favillam
Vatis amici."

The words "*cum lacrymis posuit*" are frequently found on ancient epitaphs, and it is recorded that a glass bottle supposed to be filled with tears has occasionally been found in an urn.

Some time after desecrating the ancient burying-place, which had for so many centuries been undisturbed except by ordinary agricultural operations on the soil above it, and which was held so sacred under the Roman law that any one disturbing graves was liable to instant death if discovered, my attention was called by the tenant of the neighbouring farm to the number of pieces of brick lying on the surface of the ground in a field some three furlongs distant, near Purwell Mill. On walking over it, I picked up numerous fragments of pottery, small tesseræ, and large pieces of bricks and tiles, evidently of Roman make, possessing the close texture and bright red colour peculiar to the period. Wherever these are found in the ruins of buildings or walls, whether at St. Albans, Brading, Silchester, Cirencester, Wroxeter, Bignor, Colchester, or on the Continent, as near Ems, Trèves, Nismes, etc., they are usually of the same hue, bright red. Scattered about with the above were chipped flints and flakes, with pieces much resembling those set in wood for making the tribulum or threshing-sledge for rubbing out the grain, and from which our word 'tribulation' is derived. There is an excellent specimen of this implement in the museum at Salisbury.

On seeing these fragments, I came to the conclusion that the remains of a villa and perhaps its farm-buildings might be found buried beneath the soil. On mentioning this circumstance to Mr. William Hill, a member of our Society, he coincided with me in this view, but it was not until November, 1884, that we set to work in earnest to search for foundations. We were rewarded by pitching upon the right place at the first trial. Only some 15 inches beneath the surface we found quantities of bricks, rubbish, and faced flints,

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with the wall of a Roman building *in situ*, and at a depth of 2ft. 6ins., we came upon the concrete floor of a room. The præfurnium, or furnace, was next disclosed, and then the flues leading to the hypocausts, used for heating the floors, these being supported on pilæ or columns of eight square bricks or tiles, about 13ins. in height and 14ins. apart. On these were laid square flooring-tiles, which were then covered with a thick layer of concrete containing a large amount of broken brick or burnt clay. We cleared out three rooms of this description: No. 1, measuring 9ft. 3ins. by 6ft. 6ins.; No. 2, 9ft. 3ins. by 14ft.; and No. 3, 8ft. 9ins. by 8ft. 6ins. These, I am disposed to think, were used as baths, or possibly might have been the winter quarters of the family. If the former conjecture were correct, No. 1, being nearest the furnace, would probably be the sudatorium, or Turkish bath; No. 2, the laconicum, or vapour bath; and No. 3, the tepidarium, or warm bath. A narrow passage led to the other part of the house, the first room (No. 5 on plan) having an elliptical alcove at the end. This might be the basilica or room used either for worship, or for conducting the business of the establishment. On either side of the alcove, outside the building, was a stoned or paved floor, which may have been the remains of the porticus or covered walk, and immediately opposite to which would be the principal garden. The floor of this room was 14ins. thick, of fine concrete, and so hard that in ascertaining its thickness we had almost to drill through it, and on striking it with a hammer the implement rebounded with great force, the concrete being as hard as, or harder than, our strongest cement. The adjoining room (No. 6) was covered with a nearly perfect tessellated floor of an unusual but simple pattern, red, with parallel white lines, and gridironed in the centre. No. 7 was a rectangular room 19ft. 3ins. long by 14ft. 3ins. broad, and beyond this, parts of two others were distinctly defined, until the floors cropped out to the surface of the land, and we were unable to trace more, although I believe the villa extended some considerable distance beyond in a northerly direction. My opinion that we only laid bare a small part is confirmed by archæologists who have had much experience in this direction.

It was interesting to notice that considerable alterations had been carried out in the building since its original erection, as at the point A, where a new præfurnium had been added, the entrance to which was floored with large roofing-tiles, perhaps from some outbuilding which had been taken down. In room No. 2 a division-wall had been built across, apparently to reduce its size. The inferiority of the later building-material was very marked, the mortar not being nearly so hard as that originally used, and without the admixture of powdered clay or brick, indicating a decadence in the art of building, which we are told commenced in Italy about the time of Augustus.

The herring-bone walling in No. 3 chamber, with the radiating bricks visible in the west face of the divisional wall, is a good specimen of Roman work. This system of walling prevails in most

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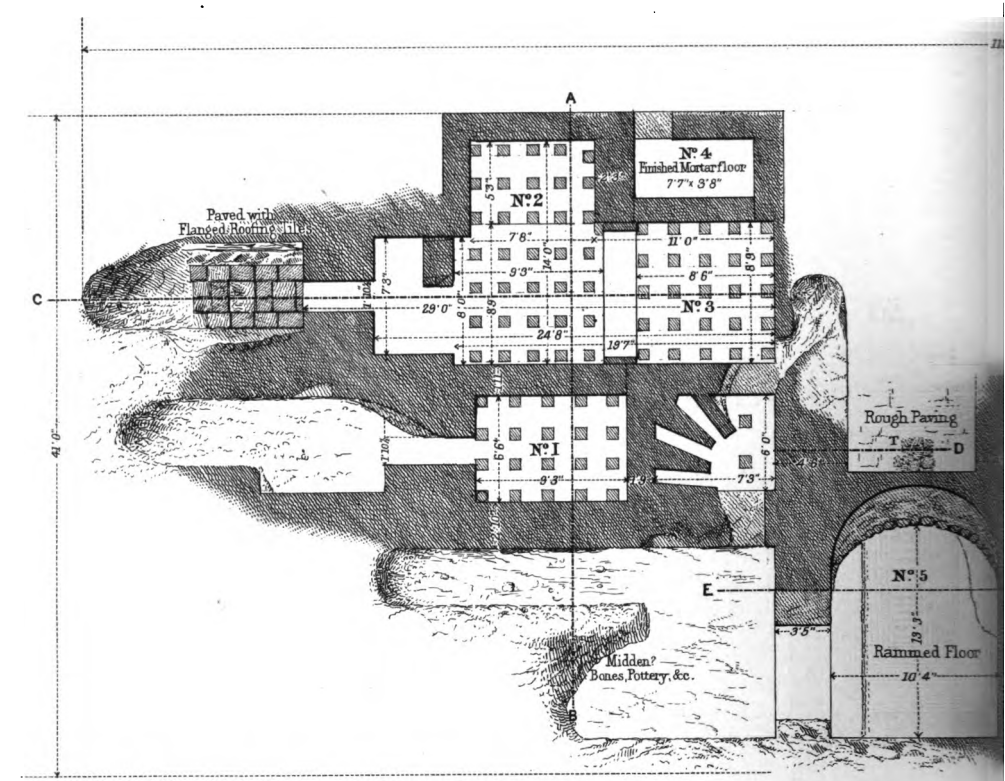
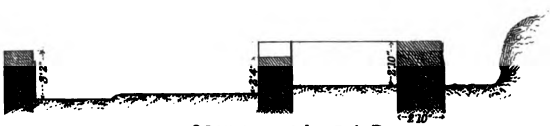
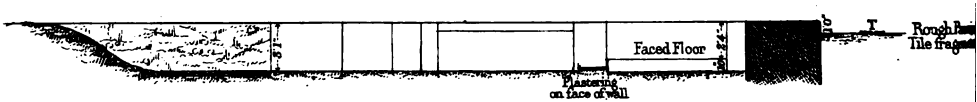




SECTION ON LINE A.B.



SECTION ON LINE C.D.

Scale, ⅛ Inch to a Foot.

10 9 8 7 6 5 4 3 2 1 0 10 20 30

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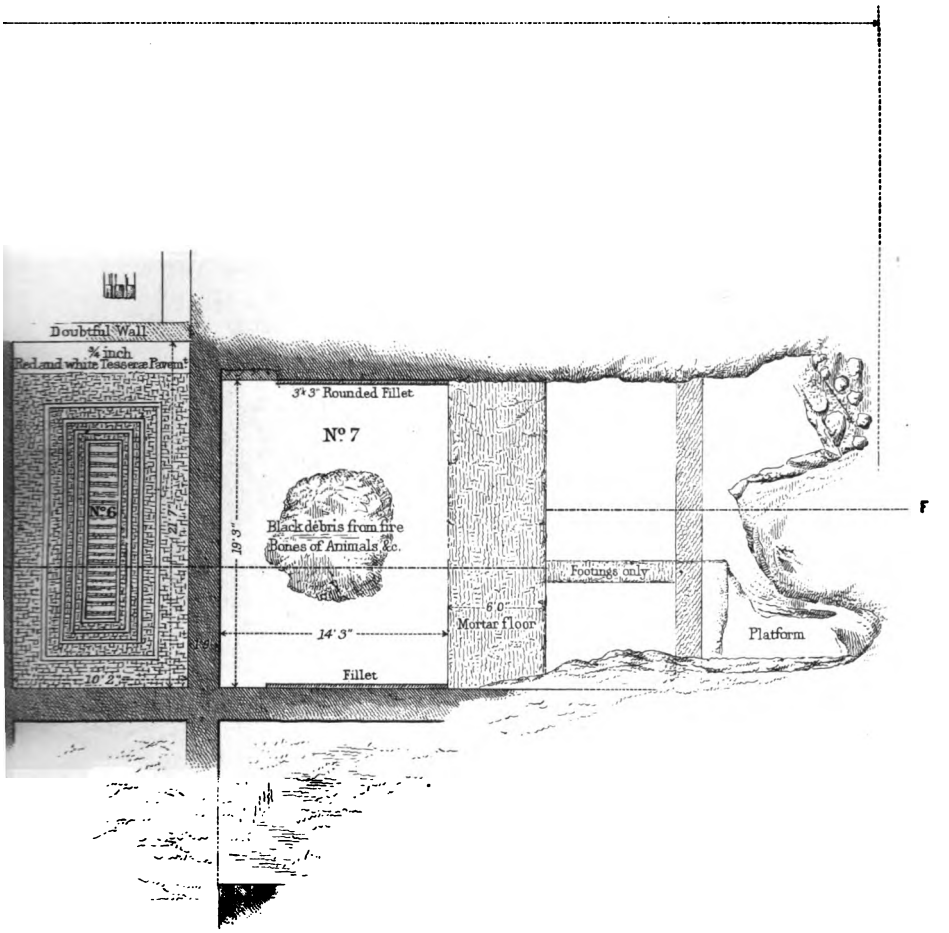

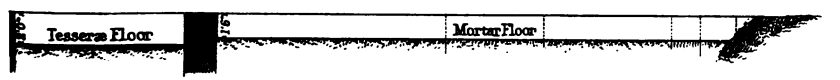

SECTION ON LINE E.F.

PLAN OF

ROMAN VILLA

excavated near Hitchin, Nov. 1884

on the estate of C.W. Wilshere, Esq.

E. Weller, lith.

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Roman constructions, and is illustrated to a great extent in the walls of Silchester, a few miles from Reading. All the walls were strengthened at the angles with courses of tiles, and in other parts similar courses and sometimes single tiles were laid in for bonding and levelling-up purposes. Structural alterations were noticed in several other parts of the building. One remarkable feature was the presence of charcoal and ashes in the centre of most of the rooms, even that in which was the tessellated pavement being in this way blackened and injured. Around were scattered bones of oxen, sheep, red deer, swine, goats, and birds, with quantities of oyster-shells; also a few bones of the fox, but none of the hare or rabbit. Probably the antipathy to hares, which Cæsar mentions in his description of Britain, held good then in the same way as it exists still among some of our population in certain parts of the country. From the untidy state of the floor, we may be justified in concluding that after the original occupants had been driven from their abode by another set of invaders, some semi-barbarous tribe took possession and dwelt there, that they kindled fires on the elaborately-designed tessellated floors in the centre of the rooms, to warm themselves and cook their food, and, gnawing the flesh off the bones, threw these aside, after extracting the marrow, as the marrow-bones were cracked longitudinally.

Considering the alterations which had been made from time to time in the villa, and the gradual decadence in the quality of the material used at each change, it must doubtless have been occupied for a long period, and this view is further confirmed by the wide range in the dates of the coins found in and around the ruins, commencing with Severus, A.D. 195, and almost continuous up to Valens, A.D. 375, probably the time of its occupation by its last Roman owner. Upwards of 40 coins came into my hands, and there were others besides which did not reach me. The following is a list of the coins which I know to have been found in and around the villa:—

COINS FOUND IN THE VILLA.

	A.D.		A.D.
Gallienus	253-268	Allectus	293-296
2 Victorinus	265-267	Constantine	306-337
Tetricus	267	2 Valentinianus II.	375-392
Tetricus, Jun.	267-272	Three barbarous imitations of Roman coins.	
Carausius	287-293		

COINS FOUND IN THE FIELD IN WHICH THE VILLA STOOD.

	A.D.		A.D.
Severus	193-211	2 Constantinus II.	335-340
Gallienus	253-268	Crispus	317-326
Salonina (wife of Gallienus)		2 Constans	335-350
Victorinus	265-267	Constantius II.	335-361
Tetricus	267	Magnentius	350-353
Tetricus, Jun.	267-272	Gratianus	378-383
Claudius Gothicus	269-270	Valentinianus	375-392
Carausius	287-293	Valens	364-378
Allectus	293-296	Several barbarous imitations of Roman coins.	
4 Constantine	306-337		

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Many cart-loads of broken roofing, flooring, and flue-tiles, together with faced flints, were thrown out in the rubbish from the excavation.

The paint or fresco on the walls retained in places the colour as brightly as when first put on, and, while most of the ornamentation was in straight lines, there were some rude indescribable devices. In one case the wall, with the plaster uninjured, was within seven inches of the surface, which is still more remarkable, and proof of the excellent quality of the building-material, as the soil is wet, and the land has been tilled by the plough for ages.

In addition to the articles already mentioned there were found in the *débris*, bone pins, a band for ladies' hair, pieces of glass vessels of fine quality, window-glass and thick bottle-glass, iron nails, an iron gouge, a style for writing on wax, rubstones for sharpening knives, with oxide of iron still adhering, oyster-shells from the best natives (?), a key, pieces of bronze, and a pretty little bronze steel-yard for weighing small articles, perhaps the precious metals or medicines, similar to those now in use at market-stalls; also Upchurch ware from Kent, mortaria of white Lyons ware, and a curious perforated lid, which was probably the top of a scent-jar. Amongst the bones were also found, at the depth of three or more feet, a number of the pretty little spiral shells of *Achatina acicula*, which are frequently turned out where animals have been buried. This mollusc has a peculiar perception as to where its food lies, for its shells are occasionally found at a depth of 7 or 8 feet in human graves.

From the extent of this villa and the substantial way in which it was built, there can be no doubt but that it was once the residence of a person of some distinction, and was chosen for its salubrious position. It is interesting to note its proximity to remarkably fine springs of water, welling up from the chalk. Good and clear water was a first consideration in choosing a site for a residence, and Vitruvius tells us that the ancients used to "examine the livers of beasts which fed where they designed to build, which, if they found vitiated, they attributed it to bad water or pasturage, and concluded it would not fare better with themselves if they should settle there, as their own diet must be of those beasts, and they would be obliged to partake of the same water."

In addition to pure water, other luxuries attached to Roman villas were fishponds and places set apart for the breeding of snails and dormice, both of which are often mentioned in connection with Roman cookery. The places in which they were kept, called Cochlearia and Gliraria by Varro, are thus described by him: "A proper place in the open air is to be provided to preserve snails, which you must compass all round with water, that you may find those you put there to breed, as well as their young ones. I say they are to be encompassed by water, that they may have no opportunity of escaping. The place may be made dewy by bringing in a pipe and fitting small cocks to it, which may eject the water so as to make it fall upon some stone and diffuse itself widely." "The

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Glirarium is managed in a different manner, being surrounded by walls, not water. The whole is covered with stone or plaster within, to prevent the dormice from creeping out. There ought to be trees in it, that may bear acorns, but when they do not bear fruit, you must throw within the walls acorns and chestnuts for them to feed upon. You must make large holes for them to breed in." *Helix Pomatia*, which still abounds on our Chalk, is said to have been imported by the Romans.

An apiary was absolutely necessary, as honey was much in request, and was used for much the same purposes as we now use sugar. Virgil, in his fourth Georgic, describes the wonderful qualities of the bee, and gives the following description of an apiary:

> "First for your bees a quiet station find,
> Devoid access of the all-insulting wind,
> Their haunts secure from sporting kids and sheep,
> Which morning dew from flowers and blossoms sweep.
> Muskins and other birds infest the hive,
> Far from your bees enamelled lizards drive,
> The swallows catch them flying, then convey
> To their expecting young the luscious prey."

Then, describing stones which he recommends should be placed in water to enable the bees to drink, he says:

> "The bees will on these frequent bridges stand,
> And to the sun their glittering wings expand,
> The verdant lavender must there abound,
> There savory shed its pleasant sweets around,
> There beds of purple violets should bloom,
> And fragrant thyme the ambient air perfume."

An osier-bed was also thought very desirable, probably to provide baskets in which to pack presents for sending to friends.

All these might easily have been provided on this site, with a terrace round the house, a sloping lawn, at the side of which the box-tree was cut into the forms of various animals, a place for practising chariot-exercises, a farm-house, a park, a kitchen-garden, and many other surroundings of a Roman country house.

Besides the places already mentioned I should refer to Wilbury Hill, a commanding position on the Icknield Way, about 2½ miles N.E. of Hitchin, where traces of an ancient camp are distinctly visible, with a rampart formerly surrounded by a ditch. Many relics have been found here from time to time, including a few coins. There is also a large tumulus very near. On the site of the residence of Mr. W. T. Lucas, at Foxholes, half a mile west of the town, several Roman antiquities were recently dug out, consisting of bronze armlets and ornaments, fibulæ, Samian dishes, knives, and several cinerary urns; also skeletons, one being of gigantic size and supposed to be that of a man nearly seven feet in height.

On Bury Mead, close to Hitchin, whilst it was being prepared for sewage-disposal, several Roman bottles and pots and a few coins were found. On the chalk hills, about 4½ miles to the west, is an unusually perfect entrenchment, named Ravensburgh Castle, en-

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closing some twelve acres of land, and rising abruptly from a deep ravine; this is probably an early British camp, though commonly attributed to the Danes. I have not heard of Roman or Saxon remains having been found on the site, which surely would have been the case had the camp been used by either as a post for defence, but possibly further explorations might expose some to view. Small worked flint implements are frequently picked up in and around the enclosure. I have also found around my own residence at Fairfield, Hitchin, many pieces of ancient British pottery, and urns containing cremated bones.

I believe the whole of the higher ground in this district was at one time thickly populated with its ancient inhabitants, and then by the Romans, whose coins are universally distributed throughout the district.

EXPLANATION OF THE PLATES.

Plate II.

Iron Weapons found near Astwick. Scale one-fourth natural size. Fig. 1. Sword. Figs. 2-6. Spear- and lance-heads (fig. 4 of unusual shape). Fig. 7. Dart. Fig. 8. Knife. Fig. 9. Bent rod, use unknown. Fig. 10. Boss of a shield. Fig. 11. Probably tip of boss. Fig. 12. Pin passing through boss at base and forming the handle of the wooden shield. (See p. 40.)

Plate III.

Samian Ware found near Astwick. From a photograph. Scale about one-fourth natural size. The names given are the potters' marks, as far as they can be made out. (See p. 40.)

Plate IV.

Roman Pottery found at Great Wymondley. From a photograph. Scale about one-eighth natural size. The potters' marks can only be made out on three of the dishes, as indicated. (See pp. 40-41.)

Plate V.

Foundations, floors, and parts of walls of Roman Villa discovered on land belonging to C. W. Wilshere, Esq., near Purwell Mill, between Hitchin and Great Wymondley. From a plan drawn by Mr. Henry Hodge, Architect. Scale one-twelfth of an inch to a foot. (See pp. 43-47.)

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V.

REPORT ON INSECTS OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1885.

By F. W. Silvester, F.R.Met.Soc.

Read at Watford, 20th April, 1886.

It once more becomes my duty to present the annual report on Insects observed in Hertfordshire. The whole of the insects in the Royal Meteorological Society's list, with the exception of the fern-chafer, have been noticed during the past year, and I am indebted to the following gentlemen for being able to present so full a calendar:—Mr. John Hopkinson (Watford), Mr. F. G. Lloyd (Croxley), Mr. J. J. Willis (Harpenden), Capt. R. B. Croft (Ware), and Mr. R. T. Andrews (Hertford). The following observations have been made:—

Melolontha vulgaris (cockchafer), seen at Harpenden, June 1st.

Timarcha lævigata (bloody-nosed beetle), at Harpenden, May 22nd.

Lampyris noctiluca (glow-worm), at Harpenden, July 3rd.

Apis mellifica (honey-bee), at Watford, Feb. 5th; Ware, Feb. 10th; Harpenden, Feb. 12th.

Vespa vulgaris (common wasp), at Watford, April 20th; Croxley, April 25th; Harpenden, April 27th.

Pieris Brassicæ (large white butterfly), at Watford, March 29th; Harpenden, March 30th; Hertford, April 17th; Croxley, April 19th.

Pieris Rapæ (small white butterfly), at Hertford, April 16th; Watford and Croxley, April 19th; Harpenden, April 20th; Ware, April 21st.

Anthocharis cardamines (orange-tip butterfly), at Hertford, May 21st; Harpenden, May 23rd.

Epinephile Janira (meadow-brown butterfly), at Harpenden, June 7th; Watford, June 10th; Hertford, June 15th.

Bibio Marci (St. Mark's fly), at Harpenden, June 13th.

The concluding remarks of my last year's report (with regard to the enormous loss sustained by insect-injury to timber) were productive of the following letter from Mr. Gadsden, of Sheppy's Farm, Bedmond:—"By the bearer I send the grub found in an ash tree, which was somewhat decayed and blown down; the tree might be 100 years old or more. I put this grub and another in a drawer, but they gnawed their way out at one corner, and this one was crawling about; the other I could not find. I send some of the tree where it had bored holes through the timber." I found the injury to the wood to be the work of the larva of *Cossus ligniperda*, the goat-moth (so called from its strong and peculiar smell) which bores into the live wood and often lives there for three or more years before turning into the chrysalis. Sixty have been found in one tree. Miss E. A. Ormerod, F.R.Met.Soc., in her 'Guide to Methods of Insect Life,' gives the following remedial measures: "Something may be done by thrusting a stout wire up the boring; if the end comes back moist with white matter on it

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the caterpillar has been reached; or, by means of a hooked wire, the caterpillar when feeding near the outside of the tree may be drawn out. Another good plan is to inject paraffin by means of a sharp-nozzled syringe into the tunnel; any other poisonous fluid or the fumes of anything poisonous might be applied in the same way, and a bit of soft clay kept well pressed up to the mouth of the hole would keep the application from escaping." The injury effected by this timber-pest is well shown in a portion of the ash tree which Mr. Gadsden sent to me, and through his kindness those who are present will be able to see the destruction wrought by *Cossus ligniperda*. The other part of the tree, at the request of the Consulting Entomologist to the Royal Agricultural Society, has been prepared by Mr. Mosley, Beaumont Park, Huddersfield, as a specimen for the Museum at Kew Gardens. It is gratifying that our Society should be able to make an acceptable contribution towards completing the examples of insect-injury in such an important collection.

Dr. Brett has informed me that Dr. Peter Hood noticed the codlin-moth in his garden at Watford last year, though not in such numbers as usual, and to this he attributes a large crop of small apples. He has observed that in the spring, when apples are about to set, the codlin-moth lays an egg in the immature apple; the larva hatched from this eats the core of the apple, and in course of time the apple falls and the larva eats its way out. The tree being thus thinned, the apples are less numerous but finer when the codlin-moth is abundant than when it is scarce. I am also indebted to Dr. Oswell Livingstone, of St. Albans, for the following valuable communication on the codlin-moth:—"You ask me to send you an account of the ravages of the larvæ of the codlin-moth in my garden during the last two summers, and I am glad to do so now, hoping that there may be some remedy found for the pest. The codlin-moth (*Tortrix pomonana*) is small, brown, and rather insignificant-looking, which makes it difficult to detect in the crevices of the bark of trees, where it loves to conceal itself during the daytime. In the evening it leaves its hiding-place, and flies about among the apple trees, resting on a young apple here and there to lay an egg in the crown of the fruit. In due time this egg is hatched, and the young larva immediately eats its way into the substance of the apple, which, however, does not cease growing till the larva has reached its full size. At this period of its life the caterpillar seems to require stronger nourishment, and so attacks the core, eating the pips clean out, after which it makes its way to the surface, lowers itself to the ground, and proceeds to take the form of the chrysalis. The apple, of course, loses its vitality and soon drops off. In the spring of 1884 and 1885 my apple trees were loaded with fine, healthy young apples, but as the summer went on and the apples reached a certain size they dropped off, and the ground under the trees was covered with young fruit. Each of these apples contained the galleries excavated by the larvæ of the codlin-moth. Out of an excellent crop of apples, as they

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appeared in May, I obtained not more than three dozen really sound ones. In a small garden, perhaps coating the trunks and branches of the trees with a sticky substance might be of some use in destroying the moth, but in a large orchard this would be difficult. Possibly you may hear of some other plan." Miss Ormerod, to whom I applied, answers Dr. Livingstone's closing remarks thus: "I should think that such measures as gently shaking the tree so that the worm-eaten apples might fall, and then at once having them gathered up, before the caterpillar had time to effect its exit (which it does very promptly according to report), would greatly diminish the amount of future attacks. Personally, I do not feel at all sure that the caterpillar does leave the fallen fruit with the expedition stated. I have seen the pest present when to all appearance there had been plenty of time for it to crawl away. Therefore, I think, gathering up all fallen apples which have come down (presumably from caterpillar-attack) is desirable, and of course they should be destroyed. Amongst various ways of keeping the caterpillars from going up the stem, might it not be of service to try just smearing a band of Davidson's composition round the base of the trunk? This answers well for stopping foot-travellers of other insect tribes, and perhaps I should add that it is sold (at per ton if wished) by Messrs. James Dickson and Sons, Newton Nurseries, Chester. It has been found that the winter larvæ of the codlin-moth hibernate sometimes on the bark from one to six inches below the ground, and that they are especially to be found where there are decayed roots, or rather where the stem decays near the surface. In this case great numbers of larvæ have been found. This observation is from Mr. Cook's Californian report. He is a most trustworthy authority, and it would be well worth while to find if the same habit prevails in this country. I should also consider that, as the caterpillars shelter under bark, careful pruning, scraping, and scrubbing with soft soap would be exceedingly good means of routing them out if applied before the 'genial spring weather' has set the year's work agoing. The attack is a great evil in California and South Australia, and I am constantly on the watch to learn whether it is brought over to us in addition to what we have of our own, in imported fruit, for it may spread from the packing-cases or baskets. I have my own apple trees scrubbed and pruned and well looked to, and except from frost have no cause of complaint." It will thus be seen that it is possible to ward off this insect-pest, and a little attention to our orchards and fruit-gardens, as recommended by Miss Ormerod, will amply repay for the trouble.

Nearly all the farmers in Hertfordshire and elsewhere have suffered from the great prevalence of aphides, whose attacks on our crops were favoured by the drought. As a consequence an almost universal partial failure of turnips and mangolds has been the result, and a serious loss has been incurred by those who at the present moment are passing through a trying period of agricultural depression. Writing from Harpenden, Mr. Willis says that honey-

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dew was exceedingly plentiful, and as aphides were so abundant, this is not at all astonishing. The following cutting from the 'Hertfordshire Mercury' of the 8th of August has been forwarded to me. I insert it without comment, but I may add that Mr. Flisher, of St. Albans prison, recently told me that the reported swarm of flies (aphides) was seen by himself when exercising the prisoners. "A Swarm of Flies in St. Albans.—A contemporary* states that on Saturday evening, between seven and eight o'clock, a swarm of green flies was seen passing over the recreation-ground at the prison. The swarm, which extended several hundred yards, and was several yards in breadth and depth, formed a dense black cloud, which could only be compared by those who saw it to a flight of locusts. Strange to relate, after the swarm had passed over, the recreation-ground of the prison, which had for several days previously been literally covered with this green fly, was almost entirely deserted, the unwelcome intruders having evidently joined their companions on the wing. After leaving the prison, the insects flew across the 'Fifteen Acre' field, and were last seen going in the direction of Smallford. One of the riders in the employ of Mr. East, of Highfield Hall, states that he met a similar swarm on the road leading from Wheathampstead to Harpenden. He was proceeding along the road on horseback on Saturday last, between twelve and one o'clock, when he met the swarm, which he estimates at about 400 yards long, and several yards in width and depth, flying close to the ground. The horse, rather than face the swarm, placed its head in the hedge until the insects had passed. A lady who was also passing at the time was compelled to put up her umbrella, this being completely covered by the flies."

* Since ascertained to be the 'Hertfordshire Standard.'

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VI.

NOTES ON BIRDS OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1885.

By John E. Littleboy.

Read at Watford, 20th April, 1886.

For seven successive years I have had the pleasure of laying before our members particulars respecting the occurrence of rare birds observed or taken within the limits of Hertfordshire. Hitherto I have restricted such notices to occurrences that have taken place since, or inclusive of, the year 1877. I am now about to commence a new departure and to register all well-authenticated occurrences irrespective of a particular date. For the first time since I have had the honour of acting as ornithological registrar for our Society, I have no species new to Hertfordshire to report as having occurred during the past year. I fall back on birds shot prior to 1877, and I have been fortunate in obtaining a goodly number. Thanks to Mr. A. Holland Hibbert, I am able to record five additional species from the collection at Munden House. These birds were all shot on the Munden estate; only a few of the dates on which they were taken have been preserved, but Mr. Hibbert informs me that the collection was commenced by his great-grandfather, Mr. George Hibbert, and completed by Mr. Nathaniel Hibbert, and his late uncle, Mr. Parker Hibbert. Mr. Hibbert very pertinently remarks that "in the immediate neighbourhood of Munden are certain temptations which readily account for the visit of rare birds to the district, Bricket Wood being a wild, wooded locality of about 800 acres in extent, and the river running close by it." He has most kindly supplied a number of birds from his collection for exhibition this evening. In addition to the Munden birds, which include the kite, the ruff, the lesser black-backed gull, the smew, and the red-breasted merganser, I have obtained information respecting eight others—the rock-thrush, the woodchat shrike, the roller, the white-tailed or sea eagle, Montagu's harrier, the merlin, the oyster-catcher, and the redshank. These additions increase our Hertfordshire avifauna to 179 species, and, in accordance with my previous custom, I shall now briefly notice them.

1. The Rock-thrush (*Monticola saxatilis*).—The occurrence of this very rare bird in Hertfordshire is recorded by Yarrell.* It was shot on the 19th of May, 1843, at Therfield, was mounted by Mr. Norman, of Royston, and is now in the possession of Lord Braybrooke. There is only one other authenticated instance of its appearance in England, but it forms the subject of an excellent illustration in the first number, recently published, of Lord Lilford's 'Coloured Figures of British Birds.'

2. The Woodchat Shrike (*Lanius pomeranus*).—Mr. John H. Gurney, jun., writes to me that the Rev. H. A. Macpherson was fortunate in observing a woodchat, near Hertford, in May,

* 'British Birds,' 4th ed. vol. i, p. 292.

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1873, and that the information may be thoroughly relied on. I notice that this occurrence is also reported by Professor Newton in the new edition of Yarrell's 'British Birds.' The woodchat is only an accidental visitant to England. Its habits are very similar to those of its congener, the red-backed shrike, differing principally from that bird in its choice of a nesting-place. The red-backed shrike generally selects a hedgerow or a furze-bush, the woodchat always chooses a tree, and appears to prefer the oak. It feeds "on beetles, grasshoppers, and many other insects,"* which, like other shrikes, it impales on thorns for the purpose of preservation. It feeds also on small birds and mammals. The woodchat was first identified, as a British bird, by the Rev. Gilbert White, and reported in a letter to Mr. T. Pennant, dated Selborne, August 30th, 1769. It is described as "Lanius minor cinerascens cum maculâ in scapulis albâ."† It has since been taken in Surrey, Nottinghamshire, Derbyshire, Worcestershire, Yorkshire, and, I am pleased to add, in Hertfordshire.

3. The Roller (*Coracias garrula*).—The Rev. C. A. Johns, in his very popular work, 'British Birds in their Haunts,' records the capture of a roller on Chipperfield Common, on the 20th of September, 1852. Mr. Johns was, at that time, residing at Callipers, and he mentions the roller as having been shot "close to my garden." I find that the occurrence is also recorded by Professor Newton in the fourth edition of Yarrell. The roller can only be classed among accidental visitors to the British Isles. It breeds in some districts of Southern Europe, in Algeria, Palestine, Asia Minor, and South-western Siberia, and winters in Arabia, the valley of the Upper Nile, and throughout Southern Africa.‡ This is one of the most brilliant and conspicuous of British birds; its head, neck, and the upper portion of its body are of light blue, shaded off with green, and if it could only be induced to visit us in the early spring, it might be considered satisfactorily to explain the much-debated and enigmatical reference by Alfred Tennyson in 'In Memoriam' to "the sea-blue bird of March."

4. Montagu's Harrier (*Circus cinereaceus*).—A Montagu's harrier was shot by Captain Young at Hexton, near Hitchin, in the year 1875, and is still in his possession. This species was first recorded as British in the 'Transactions of the Linnæan Society' in the year 1803. It is at present only an accidental visitor to the British Isles. It is a pale, slate-grey bird, with black primaries, and a black bar across the secondaries; it frequents dry moors, downs, and corn-fields, its food consisting principally of frogs, lizards, mice, moles and grasshoppers.§ In its habit of flight, and general appearance, it nearly resembles the hen-harrier, a description of which will be found in my report for 1883.

* Seebohm's 'British Birds,' vol. i, p. 612.
† 'Nat. Hist. Selborne,' ed. 1832, p. 93.
‡ Seebohm's 'British Birds,' vol. ii, p. 327.
§ *Ib.*, vol. i, p. 133.

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5. The White-tailed or Sea Eagle (*Haliaëtus albicilla*).—A white-tailed eagle was shot some years ago at Sacombe, and is now in the possession of Mr. Abel H. Smith, M.P., Woodhall Park. A hundred years ago the white-tailed eagle was tolerably abundant in Scotland, and it is reported to have bred in Westmoreland, Cumberland, and other English counties. At present it is an accidental straggler to our shores, but is still occasionally to be met with on the west coast of Ireland. Mr. Henry Seebohm alludes to it as follows:—"Like the golden eagle, the present species will often sit, for long intervals, silent and motionless, on some tall rock-pinnacle, dreamily scanning the country or the water below. It will then launch itself heavily in the air, mounting upwards, in wide curving flight, and now, sailing with wings fully expanded, and the tips of the primaries slightly recurved, will sweep along over mountain, moorland-waste, and sea, advancing seemingly but with little effort."* A few words attributed by Sheridan Knowles to the Swiss patriot, William Tell, are so strikingly in accord with this description that I shall venture to quote them:—

> "Scaling yonder peak,
> I saw an eagle, hovering near its brow,
> O'er the abyss: his broad expanded wings
> Lay calm and motionless upon the air,
> As if he floated there without their aid,
> By the sole act of his unlorded will,
> That buoyed him proudly up."

6. The Kite (*Milvus ictinus*).—Conspicuous among the rare birds at present preserved at Munden House is a kite; the date of its capture cannot be positively ascertained, but it is known to have been shot on the Munden estate. At the commencement of the present century the kite was tolerably abundant in some of the midland counties of England. Yarrell states that in Hertfordshire and Essex it commonly passed under the name of "Puttock." It is still to be met with in many of the Scotch glens, and can readily be distinguished among the British Falconidæ, even when at a distance on the wing, by its long forked tail, and its graceful, gliding flight.† Montagu states that "it is chiefly observed in the more-wooded districts where timber-trees abound," ‡ and it seems very probable that the proximity of Bricket Wood may account for its being taken at Munden.

7. The Merlin (*Falco Æsalon*).—Mr. James H. Tuke informs me that a merlin was shot near Hitchin. The merlin is one of the smallest of British hawks. It is a bluish-grey bird, more or less tinted with dull red about the neck and breast. It is a summer migrant, and nests in Scotland and the north of England. It will be remembered that Mr. Henry Seebohm, when lecturing in this room, gave us some very interesting particulars respecting the nesting of the merlin on moors in the neighbourhood of Sheffield. It is a very courageous bird. "In spirit," writes

* 'British Birds,' vol. i, p. 89.
† Yarrell's 'British Birds,' ed. 4, vol. i, p. 92.
‡ 'Ornithological Dictionary,' ed. 1833, p. 283.

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Morris,* "it is nulli secundus," and the quaint author of the 'Book of Falconrie' mentions merlins as "passing good hawks and verie skilful." Macgillivray† informs us that the merlin was "formerly trained to catch larks, snipes, woodcocks, and young partridges, and that it appears to have been a favourite with the gentle ladies of the good old times." Sir Walter Scott alludes to it as follows, in his 'Lay of the Last Minstrel' (canto vi, stanza v):—

> "The Lady by the altar stood;
> Of sable velvet her array,
> And on her head a crimson hood
> Guarded with gold, with ermine lined;
> A merlin sat upon her wrist,
> Held by a leash of silken twist."

And to this stanza the following note is appended:—"A merlin was actually carried by ladies of rank, just as a falcon in time of peace was the constant attendant on knight and baron."

8. The Red-breasted Merganser (*Mergus serrator*).—This bird is from the Munden collection. It was shot between 1840 and 1850. The red-breasted merganser, one of the most handsome and showy of the duck tribe, is only a winter visitor in England. It is resident in Scotland, and breeds on many of the lochs north of the Clyde. It is a circumpolar bird, its breeding-range extending, in Scandinavia, to the North Cape. Like the smew, the red-breasted merganser is an expert diver; it uses its wings as well as its feet in its progress under water, and in this manner supplies itself with small fish, which, when caught, are immediately brought to the surface. It feeds on crustaceans and molluscs, but does not appear to eat vegetable matter.

9. The Smew (*Mergus albellus*).—The smew or nun, as it is sometimes called, is a small but elegant duck. The specimen that I have the pleasure of exhibiting is taken from the Munden collection, and was shot on the 26th of December, 1846, by Mr. Nathaniel Hibbert. It is a rare winter straggler to the British Isles, and appears to prefer inland waters. It breeds in Iceland, Siberia, and the north of Russia, Mr. Seebohm having been fortunate enough to secure its eggs in the valley of the Petchora, a few miles south of the Arctic circle. The smew feeds principally "on small fish, crustaceans, and aquatic insects, which it obtains without difficulty, as it is an excellent diver and pursues its prey under water with great rapidity."‡

10. The Oyster-catcher (*Hæmatopus ostralegus*).—In the month of February, 1868, an oyster-catcher was shot by Mr. Wilshin on the Elstree Reservoir, and is now in his possession. I am indebted to Mr. E. P. Thompson, of Elstree, for this information. The oyster-catcher belongs to the class Grallatores or waders. It is resident in Scotland and the north, and is only met with in our

* 'British Birds,' vol. i, p. 112.
† 'Rapacious Birds,' 1836, p. 219.
‡ Yarrell, 'British Birds,' ed. 4, vol. iv, p. 506.

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southern counties during the winter months. Montagu* informs us that its principal food consists of marine insects and shellfish, and that from its adroitness in getting at an oyster, a feat performed by killing the oyster when the shells are partly open, it has acquired its name.

11. The Ruff (*Machetes pugnax*).—I am indebted to the Munden collection for the mention of this bird. The beautiful specimens now exhibited were shot between the years 1840 and 1850. The ruff is one of the most noticeable of British waders. It formerly bred abundantly in the fen-districts of Lincolnshire, and Montagu relates that twenty-seven dozen of these birds were taken at one time by a Spalding dealer for artificial naturalisation at Chatsworth and in Ireland. At present it is a rare summer migrant. The male bird is distinguished during the breeding-season by a very conspicuous collar or ruff that surrounds its neck, and from which it takes its name. This ruff varies considerably in colour, and in the autumn it is lost altogether. The female, or reeve, is much smaller and plainer in plumage than the ruff, but it is said to exceed the male sex in number in the proportion of about three to one. This disproportion will probably account for the fact that, unlike most of its class, the ruff is polygamous. Contests take place annually between the male birds for the favour of the reeves, and these amatory battles are conducted in a most systematic and businesslike manner. I shall venture to summarize an admirable description which has been given of them by Mr. Henry Seebohm.† The males contend in single combat for the right of being "Cock of the walk," and for this purpose suitable battle-fields are chosen, sometimes on a slight elevation, but more generally a patch of open ground four or five feet across, with short level grass, and so situated as to command the view of the admiring females, is selected. The same ground is chosen year after year, and two or three duels are frequently going on at the same time. These contests are not commenced until the ruff or collar is fully grown, and are discontinued as soon as the feathers on the neck begin to fall out, which happens about six weeks later.

12. The Redshank (*Totanus Calidris*).—In my report for 1880 I recorded the taking of a greenshank by Mr. A. Dyson, and, at the same time, he was good enough to show me a beautiful specimen of its congener, the redshank, also shot by himself on the Colne meadows. It was killed prior to 1877, and I have not, on that account, hitherto noticed it. The redshank, although abundant on the coasts, is met with in Hertfordshire only as an occasional visitor. Mr. Seebohm describes its habits as follows.‡ It is a resident, frequenting almost all parts of the coast in autumn and winter, and retiring more or less inland in summer. It breeds in all suitable districts throughout England, especially in the low-lying eastern counties. Hertfordshire is singularly free from swamp

* 'Ornithological Dictionary,' p. 351.
† 'British Birds,' vol. iii, p. 114.
‡ *Ib.*, vol. iii, p. 140.

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or fen, and to this circumstance may probably be attributed the comparative scarcity of the redshank.

13. The Lesser Black-backed Gull (*Larus fuscus*).—A gull belonging to this species is now exhibited. It has been preserved in the Munden collection. The lesser black-backed gull is a resident on our coasts. It breeds in Scotland, in England north of the Tyne, especially on the Fern Islands, in Wales, Devonshire, and Cornwall. "It is not quite so large as the herring-gull, but more than twice the size of the common gull." It has a graceful skimming flight, and, when passing over land, does not rise high. It feeds on small surface-swimming fishes, insects, caterpillars, grubs, and worms, and in the fields contiguous to the coast may occasionally be seen following the track of a plough.

The following observations of the arrival, etc., of our summer migrants and other visitants have been made.

Summer Migrants.

Species.	Locality.	Date.	Observer.
Nightingale (*Daulias Luscinia*)	Oaklands, St. Albans	Apl. 15	A. Lewis.
	Harpenden	,, 17	J. J. Willis.
	Hailey Hall, Hertford	,, 19	H. C. Heard.
	Watford	,, 20	J. Hopkinson.
	Croxley, Rickmansworth	,, 21	F. G. Lloyd.
	Elstree	,, 21	E. P. Thompson
	Hitchin	,, 26	W. Hill, jun.
	St. Albans	,, 27	E. W. Arnold.
	Ware	,, 27	R. B. Croft.
	Russell Farm, Watford	,, 27	J.E.L.
	Hertford	,, 29	R. T. Andrews.
	Sawbridgeworth	,, 30	Miss Simpson.
Wheatear (*Saxicola Œnanthe*)	St. Albans	Feb. 22	Henry Lewis.
	Hitchin	Apl. 12	W. Hill, jun.
Whitethroat (*Sylvia rufa*)	St. Albans	Apl. 29	Henry Lewis.
Lesser Whitethroat (*Sylvia Curruca*)	Sandridge, St. Albans	,, 23	A. F. Griffith.
	Elstree	,, 26	E. P. Thompson
	St. Albans	,, 29	Henry Lewis.
Blackcap (*Sylvia atricapilla*)	Royston	May 14	P. F. Fordham.
Chiff-Chaff (*Phylloscopus collybita*)	Hunton Bridge, Watford	Mar. 25	J.E.L.
	Hitchin	,, 30	W. Hill, jun.
	Coleman's Green	,, 30	A. F. Griffith.
	Barnet	Apl. 3	C. Fry.
	Hitchin	,, 5	W. Hill, jun.
	St. Albans	,, 6	G. Luff.
Willow-Wren (*Phylloscopus Trochilus*)	Hitchin	Mar. 20	W. Hill, jun.
	Hunton Bridge, Watford	Apl. 19	J.E.L.
	St. Albans	May 15	Henry Lewis.
Sedge-Warbler (*Acrocephalus schœnobœnus*)	Sandridge, St. Albans	Apl. 25	A. F. Griffith.
	St. Albans	,, 27	Henry Lewis.
	Hunton Bridge, Watford	,, 28	J.E.L.
Red-backed Shrike (*Lanius collurio*)	Bernard's Heath, St. A.	May 15	Henry Lewis.
	Port Vale, Hertford	June —	N. Thrale.
Spotted Flycatcher (*Muscicapa Grisola*)	Barnet	Apl. 19	C. Fry.
	Marshall's Wick, St. A.	May 26	Henry Lewis.

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Species.	Locality.	Date.	Observer.
Swallow	Hitchin	Apl. 12	W. Hill, jun.
(*Hirundo rustica*)	Elstree	,, 14	E.P.Thompson.
	Watford	,, 14	J. Hopkinson.
	Hailey Hall, Hertford	,, 15	H. C. Heard.
	Redbournbury, St. Albans	,, 15	E. W. Arnold.
	Fanhams Hall, Ware	,, 16	R. B. Croft.
	Barnet	,, 17	C. Fry.
	St. Albans	,, 17	Henry Lewis.
	Croxley, Rickmansworth	,, 17	F. G. Lloyd.
	Hertford	,, 17	R. T. Andrews.
	Hunton Bridge, Watford	,, 21	J.E.L.
	Sandridge, St. Albans	,, 24	A. F. Griffith.
(Last seen)	Royston	Oct. 27	P. F. Fordham.
House Martin	Leavesden, Watford	Apl. 17	W. James.
(*Chelidon urbica*)	Harpenden	,, 21	J. J. Willis.
	Boxmoor	,, 25	J.E.L.
	St. Albans	,, 28	Henry Lewis.
	Redbournbury, St. Albans	,, 28	E. W. Arnold.
	Fanhams Hall, Ware	May 6	R. B. Croft.
Sand-Martin	Sopwell Mill, St. Albans	Apl. 27	Henry Lewis.
(*Cotile riparia*)	Redbournbury, St. Albans	May 13	E. W. Arnold.
Swift	St. Albans	Apl. 27	Henry Lewis.
(*Cypselus Apus*)	Redbournbury, St. Albans	,, 27	E. W. Arnold.
	Croxley, Rickmansworth	,, 30	F. G. Lloyd.
	Elstree	May 3	E.P.Thompson.
	Fanhams Hall, Ware	,, 6	R. B. Croft.
	Harpenden	,, 9	J. J. Willis.
	Sandridge, St. Albans	,, 11	A. F. Griffith.
(Last seen)	St. Albans	Aug. 19	Henry Lewis.
Wryneck	St. Albans	Apl. 19	Henry Lewis.
(*Iynx torquilla*)	Dell Field, Watford	,, 23	A. J. Copeland.
	Sandridge, St. Albans	,, 25	A. F. Griffith.
Cuckoo	Leavesden, Watford	,, 14	W. Janes.
(*Cuculus canorus*)	Royston	,, 15	P. F. Fordham.
	Barnet	,, 18	C. Fry.
	Hailey Hall, Hertford	,, 19	H. C. Heard.
	Croxley, Rickmansworth	,, 21	F. G. Lloyd.
	Elstree	,, 21	E.P.Thompson.
	Harpenden	,, 22	J. J. Willis.
	St. Albans	,, 22	Henry Lewis.
	Redbournbury, St. Albans	,, 22	E. W. Arnold.
	Sandridge, St. Albans	,, 23	A. F. Griffith.
	Watford	,, 23	J. Hopkinson.
	Fanhams Hall, Ware	,, 24	R. B. Croft.
	Sawbridgeworth	,, 26	Miss Simpson.
	Hitchin	,, 26	W. Hill, jun.
	Hertford	,, 28	R. T. Andrews.
Turtle-Dove	St. Albans	May 11	Henry Lewis.
(*Turtur communis*)	Sandridge, St. Albans	,, 11	A. F. Griffith.
Quail	Royston	,, 15	P. F. Fordham.
(*Coturnix communis*)			
Landrail	Fanhams Hall, Ware	Apl. 26	R. B. Croft.
(*Crex pratensis*)	Harpenden	,, 27	J. J. Willis.
	St. Albans	,, 29	E. W. Arnold.
	Elstree	,, 12	E.P.Thompson.
Stone Curlew	Royston	Jan. 10	P. F. Fordham.
(*Œdicnemus Scolopax*)	Barton	Oct. 3	Henry Lewis.

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SPRING, AUTUMN, AND WINTER VISITANTS.

SPECIES.	LOCALITY.	DATE.	OBSERVER.
REDWING (*Turdus Iliacus*)	Near St. Albans	Nov. 5	J.E.L.
FIELDFARE (*Turdus Pilaris*)	Royston	Jan. 7	P. F. Fordham.
	Sandridge, St. Albans	Apl. 5	A. F. Griffith.
	Royston	Oct. 4	P. F. Fordham.
RING-OUSEL (*Turdus torquatus*)	Between Hunton Bridge and King's Langley	Nov. 15	J.E.L.
BRAMBLING (*Fringilla montifringilla*)	Redbournbury, St. Albans	Jan. 11	E. W. Arnold.
	Harpenden	Feb. 20	Henry Lewis.
	St. Albans	Nov. 7	E. W. Arnold.
	Cassio Bridge, Watford	Apl. 20	E. Moon.
HOODED CROW (*Corvus Cornix*)	Royston	Jan. 2	P. F. Fordham.
	Port Vale, Hertford	Mar. 1	Norman Thrale.
SNIPE (*Gallinago gallinula*)	Redbournbury, St. Albans	Aug. 23	E. W. Arnold.

MISCELLANEOUS NOTES.

GRASSHOPPER-WARBLER (*Locustella nævia*).—Mr. A. F. Griffith reports having observed one of these charming little birds in the neighbourhood of Sandridge. The grasshopper-warbler can be readily distinguished by its very peculiar note; it may be heard occasionally, on a summer's evening, in low meadows or along the side of streams, but it is an extremely timid bird and is very difficult to approach.

TITS (*Parus major*, *P. ater*, and *P. cæruleus*).—Mrs. Brightwen, of the Grove, Stanmore, has been good enough to supply me with some interesting anecdotes respecting tits. 1st—An empty cocoa-nut, with a hole in it, was hung up near the house, for the special accommodation of these most amusing birds; a "large tit" speedily took possession of it and commenced to build; but an action for ejectment was very quickly commenced; a little "blue tit," doubtless coveting so commodious a house, attacked the occupant in the most determined and desperate manner. The case was decided by a pitched battle, the combatants, in their struggle, rolling over and over several times on the lawn. The blue tit was at last victorious, immediately took possession of the cocoanut, and successfully brought up a large family. The hen-bird became so tame that she would allow her home to be taken down for inspection, and although she would hiss and set up her feathers when touched, she did not attempt to escape. Her little birdies were fed principally with small caterpillars. I may add, from personal knowledge, that the "blue tit" is singularly pugnacious, and is generally a most successful combatant. In order to entice the tits, my daughter makes a practice of suspending a net, with fat in it, in a position readily observable from the parlour window. Battles-royal between blue tits, coal tits, and large tits are of constant occurrence, but the blue tits are invariably victorious. 2nd—A coal tit built its nest in a post letter-box; for the sake of protection the letter-box was locked, but the genius "boy" has no pity; sticks were poked down the slit used for letters, the bird was killed, and the eggs were broken. 3rd—A blue tit built in the lower part of a stone vase;

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there was a hole for drainage at the bottom, and through this the little bird found a circular space just suited for its nest. Of course the vase could not be filled till the domestic duties of the family were ended. 4th—The following dialogue will tell its own tale: —Gardener: "If you please, ma'am, what am I to do with those blue tits?" Mrs. B.: "And what have the blue tits been doing?" Gardener: "Two of them have been sitting close to the entrance of one of the hives and have picked off and killed every bee as it came out, and now they have begun on a second hive." Mrs. B.: "Well, gardener, you had better stick some potatoes all over with feathers and hang them up in front of the hives; that will most likely frighten them away." Gardener: "I've done that, ma'am, already, and the tits just sit on the potatoes and look at me." Eventually one of the offenders was shot and hung up as a "frightful example" to the rest. This proved an effectual warning.

Red-backed Shrike (*Lanius collurio*).—Several red-backed shrikes have been again reported. On May 15th a nest, with two eggs, was found near Redbourn Bury by Mr. E. W. Arnold; on the same day a cock, in fine plumage, was observed on Bernard's Heath by Mr. Henry Lewis. On June 7th a nest, with four eggs, was found near Royston by Mr. P. F. Fordham. On July 22nd Mr. Henry Lewis found a shrike's nest in a furze-bush at Nortonbury, close to the moat, and on the same day, by carefully watching a bird at Leasey Bridge, was fortunate enough to discover its larder—it consisted of mice, beetles, and young birds impaled on black-thorns. Lastly, Mr. Norman Thrale informs me that three out of the four pairs of shrikes reported last year as nesting near Port Vale, have again resorted to their old haunts.

Waxwing (*Ampelis Garrulus*).—A waxwing was shot by Mr. H. How, on Cupid's Green, Hemel Hempstead, in January, 1870, and is still in his possession. It was mounted by Mr. Bowers, of Watford. Mr. How informs me that at the time the bird was shot the weather was intensely cold. I reported this species, for the first time, last year, but it is so seldom to be met with in Hertfordshire that I think it best to record its capture as now stated.

Siskin (*Carduelis Spinus*).—Siskins have been tolerably abundant. On March 4th a flight was observed by Mr. H. Lewis on alder trees near St. Albans, and on February 7th a considerable number congregated on the alder trees near the waterfall in my own meadow.

Greenfinch (*Ligurinus Chloris*).—Miss Myers, of the Grove gardens, informs me that during the early summer she noticed a boy with a nest containing four young greenfinches. Wishing to save their lives, she offered to take charge of them and rear them. This was done very successfully by feeding them on bread-crumbs and boiled egg. When completely fledged, she liberated them, but twice every day went into the gardens to feed them. Directly she made her appearance, the birds would fly towards her, perch on her head and shoulders, and eagerly consume the proffered meal. This practice was continued for more than a month, when Miss Myers had occasion to leave home for about a fortnight; on returning to

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the Grove gardens her little favourites could not be induced to renew their familiarity.

House-sparrow (*Passer domesticus*).—Mr. E. C. Blockley has kindly furnished me with the following anecdote respecting the predatory habits of sparrows:—In July last year some half dozen pieces of Honiton lace (collars and cuffs) were put on the lawn to bleach, a few pebbles being placed on each piece. About an hour afterwards the lace had unaccountably disappeared. Somebody suggested "birds," so some common frilling was put out and a watch was set. In a few moments a sparrow was seen to descend from the ivy on the back of the house, and fly up with a piece nearly a yard long. This told the tale. With the help of a ladder about thirty sparrows' nests were examined, in five of which a piece of lace was found, but the sixth was never recovered. The lace was uninjured.

Tree-Sparrow (*Passer montanus*).—In January I noticed two of these birds near the river at Hunton Bridge, and Mr. A. F. Griffith reports having seen one on March 9th on the railway, close to Beech Bottom.

Carrion Crow (*Corvus Corone*).—Mr. Marlborough R. Pryor has kindly supplied me with the following note:—In the spring a carrion-crow, which had wrought great destruction in the rookeries at Clothall in 1884, reappeared in the neighbourhood, and after working great havoc, killing more than half the young rooks, was shot by Mr. Thomas Pryor, of Baldock.

Raven (*Corvus Corax*).—Mr. Percy F. Fordham informs me that two ravens were observed on November 19th at Church-hill Farm, near Royston.

Sparrow-hawk (*Accipiter Nisus*).—Mr. Percy F. Fordham reports the finding of a nest of the sparrow-hawk with four eggs on June 21st, near Royston.

Hobby-hawk (*Falco subbuteo*).—A hobby-hawk was shot near Port Vale on the 17th of September, and has been mounted by Mr. Norman Thrale.

Osprey (*Pandion Haliaëtus*).—It will be remembered that in my ornithological report for the year 1880, I reported the taking of an osprey near the Broadwater, in Hatfield Park. It was considered at the time to be an occurrence of considerable importance, but its interest would have been greatly augmented had it been known that two others were shot, almost precisely at the same time, at Ruislip, near Rickmansworth, just beyond the boundary of our county. Respecting this event Mr. Charles Healey has been good enough to supply me with the following note:—On September 21st, 1880, an osprey was shot at Ruislip by Mr. William Cosier, and is now in his possession. Two or three days afterwards its mate was killed by one of the keepers, in the adjoining wood, and is at present in the possession of Mr. Baker, late of Eastcot. There can be but little doubt that these noble birds came over from the continent in company, and that they formed a portion of the immense cloud of Raptores which visited the eastern and southern districts of England in the autumn of 1880.

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GANNET (*Sula bassana*).—A young gannet, with down still on its head, was picked up alive near Brocket Hall, on September 29th, and has been mounted by Mr. Luff, of St. Albans. Last year I recorded the taking of a disabled gannet at Crömb Hyde, near Sandridge. The repetition of an occurrence generally so unusual in Hertfordshire is worthy of remark.

BITTERN (*Botaurus stellaris*).—Mrs. Hodgson, of Abbot's Langley, informs me that two bitterns were shot near the Tring Reservoirs in 1884. Mr. W. Hill, jun., of Hitchin, reports the killing of one of the same species in February, 1885, at Orton Head.

PARTRIDGE (*Perdix cinerea*).—Partridges have been very abundant during the season, probably more so than for many years past. Mr. A. J. Copeland informs me that a partridge's nest was found, on the 17th of June, on the top of a straw rick 12 to 15 feet from the ground. I have before recorded a similar fact, but the occurrence is a rare one.

MOORHEN (*Gallinula chloropus*). — Mr. Frederick Seebohm, of Hitchin, writes to me that a pair of moorhens hatched a brood of eight on a pond in his garden. Curiously enough they built three nests, and the male-bird might frequently be seen fathering a portion of the brood on one nest, while the female mothered the remainder on another. What requirement the third nest was intended to supply it appears difficult to suggest.

COOT (*Fulica atra*).—Mr. Henry Lewis reports having seen several coots, with their young, on water, at Nortonbury.

ALBINO SPORTS.—I have again several reports of albino sports. On the 18th of September a white sparrow was observed by Mr. H. Lewis, among a flock of others, on No-man's-land, near St. Albans. Mr. N. Thrale kindly sent me the skin of a sparrow, which he states to have been one among several others, with white on wings, tail, and head. He suggests that these may have been the young of a pair that nested near his house last year, one of which he distinctly remembers as possessing similar markings. Sports are not generally hereditary, but the incident is a very interesting one. Mr. Thrale also reports a robin with a white head; a chaffinch, which he has in his possession, also with a white head; and a blackbird, which he has observed for three consecutive years, with white head and neck.

GENERAL REMARKS.—I may report that golden plovers have been numerous in the Hertford and Royston districts. They but rarely visit the western side of our county. Flocks of dotterel have again visited the Royston downs, and the stone-curlew, or Norfolk plover, appears to be a regular summer migrant to the same locality; it has frequently been known to nest, and has now been reported for several successive years. Redwings and fieldfares are probably the most generally distributed of all our winter visitants. Redwings are the first to arrive, reaching Hertfordshire during the month of October. They are followed by fieldfares, after the interval of a fortnight or three weeks. The former frequent shrubberies and well-wooded districts; the latter prefer open fields, and may very

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generally be found in this district, during the early part of November, wherever large fields and high hawthorn hedges prevail. Both species suffered frightfully during the first fortnight of March, 1886. Redwings, which are more exclusively insectivorous than fieldfares, and are also more susceptible to the effects of cold, perished in immense numbers, and I have heard of their being picked up dead and dying in all directions. Fieldfares, naturally timid and difficult to approach, have been almost as tame as robins. I observed several, in pitiful condition, with drooping wings, and apparently unable to fly, close to the vicarage at Hunton Bridge, and, for the first time, I have seen two or three in my own garden. Large numbers of fieldfares must also have perished.

It will be noticed that the occurrence of most of our winter visitants is far more uncertain and accidental than that of our summer migrants. It is not difficult to suggest an explanation. Summer migrants wing their way to us from southern climes for the purpose of nesting and breeding, and it is an admitted fact that they will almost always return, if possible, to the locality of their birth. Winter visitants come to us from the north, not because they love our shores, but because they are driven by cold and hunger to resort to a more genial climate. There is no certainty that a wanderer from the north will revisit, year after year, the same district; he will probably remain wherever he happens to find the food that he requires, and will extend his journey southward as circumstances may dictate. This theory is well illustrated by the ascertained habits of the common wild duck. It is well known that wild ducks frequently remain with us during mild winters. When ice first covers the ponds which they frequent, they will frequently retreat to a running stream, and eventually, should necessity compel, to the sea. Perhaps it may be worthy of remark that the holly-berries, always a last resource with birds, appear to have been more completely stripped from the hedges during the recent cold weather, than I have ever before observed to be the case.

Before I conclude, may I solicit the kind assistance of our members in obtaining for me further information respecting rare birds, taken in Hertfordshire, prior to the year 1877? There must be, in many old mansions, stuffed specimens, about which detailed particulars might readily be obtained, and the record of which would materially augment the number of species at present on our county register. I have also to ask for a continuance of the efficient help that has hitherto been so constantly and liberally furnished by a large circle of correspondents, and without which it would be impossible to maintain the interest of my annual reports.

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VII.

METEOROLOGICAL OBSERVATIONS TAKEN AT THROCKING, HERTS, DURING THE YEAR 1885.

By the Rev. C. W. Harvey, M.A., F.R.Met.Soc.

Read at Hertford, 29th April, 1886.

Position of Station.—Lat. 51° 57′ N., Long. 0° 3′ W.; River District of the Rib, a small tributary of the Lea, and consequently in the Thames basin, but at no great distance from the watershed of the Thames and Ouse. *Height of Station*, 484 feet above sea-level. *Thermometers*, max. and min. in a Stevenson's screen with their bulbs 4 feet above the ground; solar and terrestrial radiation, 4 feet, and 6 inches, respectively, above the ground. *Rain-gauge*, 5 inches in diameter, and 1 foot above the ground. *Time of observing*, 9 a.m., the max. temperature, and the amount of rain being entered to the previous day.

My wet-bulb thermometer not having been in thorough working order, I have been compelled to omit from my tables the usual deductions of the humidity of the air, and in place of these I have given what to many may perhaps be more interesting, namely, the accumulated temperature above and below 42° from the 1st of January. This table gives the combined amount of the excess or defect of the air-temperature above or below a fixed standard, or *base temperature*; the base adopted being 42°, which is the *critical* value, the temperature above it being mainly effectual in starting and maintaining the growth, and in completing the ripening of agricultural crops in an European climate. It has been deduced from the mean max. and mean min. temperature for each month.

The year 1885 may be considered in the three chief meteorological features of Pressure, Temperature, and Rainfall, as a very average year, as will be seen by the following table.

Months.	Pressure.		Temperature.		Rainfall.	
	Mean 1880–85.	Diff. 1885.	Mean 1880–85.	Diff. 1885.	Mean 1880–85.	Diff. 1885.
January	30·15	−0·18	38·8	−6·4	1·43	+0·24
February	29·87	−0·27	39·9	+1·8	2·26	−0·11
March	29·97	+0·14	41·1	−1·5	1·01	−0·20
April	29·88	−0·06	45·3	+0·5	1·83	+0·70
May	30·01	−0·16	50·6	−2·9	1·17	+1·54
June	29·95	+0·08	56·7	+0·2	1·96	+0·04
July	29·91	+0·24	60·6	+0·4	2·74	−2·36
August	29·98	+0·01	59·4	−2·2	2·10	−0·83
September	29·92	−0·04	55·7	−1·5	2·71	+0·80
October	29·91	−0·21	46·8	−2·5	3·45	+1·46
November	29·95	+0·08	41·9	−0·6	2·60	+0·86
December	29·96	+0·12	38·1	−1·2	2·26	−1·44
Year	29·96	−0·03	47·9	−1·3	25·52	+0·70

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Results of Meteorological Observations taken at Throcking Rectory, Buntingford, in 1885.

Months.	Pressure of the Atmosphere.	Temperature of the Air.									Accumulated for Month.		Accumulated since Jan. 1st.	
		Means of		Adopted Mean.	Mean Daily Range.	Absolute Min. and Max.				Absolute Range.	Above 42°	Below 42°	Above 42°	Below 42°
		Min.	Max.			Min.	Date.	Max.	Date.					
	ins.	°	°	°	°	°		°		°	°	°	°	°
January	29·97	26·7	37·7	32·4	11·0	23·3	22nd	49·1	28th	25·8	*nil*	297	*nil*	297
February	29·60	36·4	47·0	41·7	10·6	25·5	21st	56·4	12th	30·6	56	92	56	389
March	30·11	31·7	48·1	39·6	16·4	28·4	7th and 24th	59·6	29th	31·2	74	170	130	559
April	29·82	37·4	55·0	45·8	17·6	26·4	4th	72·1	20th	45·7	198	54	328	613
May	29·85	40·1	56·4	47·7	16·3	31·9	8th	70·9	28th	39·2	213	23	541	636
June	30·03	48·2	67·1	56·9	18·9	39·2	11th	82·9	4th	43·7	447	*nil*	988	636
July	30·15	52·3	71·1	61·0	18·8	44·4	9th	84·3	25th	39·9	589	*nil*	1577	636
August	29·99	49·9	65·6	57·2	15·7	41·9	14th	75·3	16th	33·5	471	*nil*	2048	636
September	29·88	46·8	62·4	54·2	15·6	32·9	26th	76·1	15th	43·2	366	*nil*	2414	636
October	29·70	38·9	50·2	44·3	11·3	32·4	30th	58·8	16th	26·4	130	37	2544	673
November	30·03	36·7	46·0	41·3	9·3	28·2	18th	55·6	30th	27·4	38	90	2582	762
December	30·08	31·8	41·7	36·9	9·9	20·3	11th	55·6	1st	34·7	*nil*	158	2582	921
Year	29·93	39·7	54·0	46·6	14·3	20·3	Dec. 11	84·3	July 26	64·0	.....	.....	2582	921

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RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT THROCKING RECTORY, BUNTINGFORD, IN 1885—(*continued*).

MONTHS.	RAINFALL.					CLOUD.			WIND.									
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount 0–10.	No. of days of		Mean Force 0–12.	Number of days of								
	Ins.	Ins.	Date.	Rain or Snow.	Snow only.		Clear Sky.	Overcast.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January	1·67	0·62	31st	15	1	8·3	4	23	2·4	2	2	3	6	12	2	3	1	0
February	2·15	0·51	16th	18	0	7·3	5	16	2·4	0	2	1	0	13	7	3	2	0
March	0·81	0·42	3rd	5	2	2·4	5	9	2·6	10	3	2	1	4	3	3	3	2
April	2·53	0·51	15th	17	0	6·6	5	12	3·0	7	4	6	0	7	4	0	2	0
May	2·71	0·59	21st	15	0	7·0	0	8	2·6	7	1	1	1	5	4	5	7	0
June	2·00	0·94	8th	11	0	5·6	8	12	2·3	5	5	4	0	4	7	1	4	0
July	0·38	0·15	19th	6	0	5·3	8	13	2·0	6	6	3	0	3	6	4	3	0
August	1·27	0·18	4th	11	0	7·2	2	13	2·4	3	6	2	3	3	5	1	8	0
September	3·51	1·25	10th	22	0	6·6	3	13	2·3	4	2	1	1	8	4	3	7	0
October	4·91	1·00	23rd	20	0	6·5	6	13	2·5	3	2	3	3	2	6	4	8	0
November	3·46	0·42	26th	16	0	7·4	3	19	2·1	2	7	5	7	3	5	0	1	0
December	0·82	0·28	30th	14	2	6·7	6	16	1·8	7	2	1	1	2	8	6	4	0
Year	26·22	1·25	Sept.10	170	5	6·4	55	167	2·4	56	42	32	23	66	61	33	50	2

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The dryness of July, and also, we may add, of December, when the fall of rain barely exceeded that of March, are noticeable features. In the distribution of the rainfall we also find that the fall of the three autumn months was almost the same in amount as the fall of the first six months of the year, each representing about 45% of the total fall; thus only leaving 10% of the total fall to be represented by the rainfall of July, August, and December.

Pressure.—I have no very deep depression to record this year, the pressure never having been below 29 inches. The highest point reached was 30·63 ins. on March 14th, when an area of high pressure lay over the British Isles. On the other hand, 29·01 ins., which occurred on Oct. 10th, was the lowest point to which the mercury fell, the centre of the depression lying at the time over the west of England. The extreme yearly range of pressure has therefore been 1·62 in. The absolute range of pressure for the whole period being between 30·94 on Jan. 18th, 1882, and 28·47 on Jan. 26th, 1884, or 2·47 ins., the max. for 1885 was 0·31 lower than the absolute max., and the min. for 1885 was 0·54 higher than the absolute min.

Temperature.—The mean temperature of the year, 46°·6, proves to be slightly below the mean temperature of the whole period: the range is from 84°·3 on July 26th to 20°·3 on December 11th, which represents a range of 64°·0. The maximum temperature is higher than in 1880, 1882, or 1883, whilst the minimum has been lower in every preceding year of the period except 1884. I usually quote the four highest, and the four lowest readings of the thermometer; in the present year these are:—

Highest Maxima.		Lowest Minima.	
(*a*) July 26th	84°·3	(*a*) Dec. 11th	20°·3
(*b*) ,, 25th	84 ·2	(*b*) ,, 9th	21 ·0
(*c*) June 4th	82 ·9	(*c*) ,, 12th	21 ·7
(*d*) ,, 5th	79 ·2	(*d*) ,, 30th	21 ·9

The temperature of June 4th was the highest yet registered in that month, only once previously having reached 80°, namely on June 30th, 1883. We experienced a warm period exceptionally early in the year, the temperature on the 20th and 21st of April exceeding 70°. On April 19th it was 68°·9, on 20th 72°·1, and on 21st, 71°·5.

The warmest and coldest periods of 14 days occurred between July 16th and 27th on the one hand, and between January 12th and 25th on the other.

Warmest Period (Mean).				Coldest Period (Mean).			
July 16th	57°·7	July 23rd	58°·6	Jan. 12th	31°·4	Jan. 19th	33°·1
,, 17th	58 ·3	,, 24th	59 ·9	,, 13th	30 ·1	,, 20th	31 ·1
,, 18th	60 ·0	,, 25th	68 ·2	,, 14th	30 ·3	,, 21st	28 ·3
,, 19th	61 ·8	,, 26th	72 ·0	,, 15th	31 ·6	,, 22nd	27 ·6
,, 20th	63 ·4	,, 27th	65 ·7	,, 16th	33 ·5	,, 23rd	30 ·7
,, 21st	60 ·7	,, 28th	60 ·8	,, 17th	34 ·2	,, 24th	31 ·0
,, 22nd	60 ·2	,, 29th	58 ·3	,, 18th	33 ·4	,, 25th	33 ·8
Mean	61°·9			Mean	31°·4		

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RAINFALL.—Whilst the rainfall was nearly 8 inches more than in the previous year, it was only 0·70 in excess of the mean for the period. I have already alluded to the distribution of the rainfall throughout the year. There was an almost complete absence of heavy thunder showers during the summer; July, the month for such showers, being the driest July since 1868. Sept. 10th proved the wettest day of the year, the fall of rain being 1·25 in.; only on one other day was it as much as an inch, namely on October 23rd, when 1 inch fell; on June 8th, however, the fall was nearly as heavy, namely 0·94 inch. *Dry Periods.*—Between March 4th and April 4th rain only fell on 5 days (one snow only), the total being 0·47 in.; between June 25th and July 10th rain only fell on 2 days, the total being 0·05 in.; and between July 20th and August 3rd no rain at all was gauged. *Wet Periods.*—Sept. 2nd to 20th proved persistently wet, rain falling every day except 14th, the total being 2·90 ins.; rain fell also every day between Oct. 23rd and Nov. 4th, the total for the fortnight amounting to 2·50 ins. The months which showed the greatest excess were May and October, and those which showed the greatest deficiency were July and December. The rainfall in May and November was the greatest, and that in July and December the least for the respective months in the entire period.

I give in the following table the mean pressure, the temperature, the accumulated temperature, and the total rainfall in each of the four seasons. It will be found that the spring was both the coldest and wettest, the summer the driest, and the autumn the wettest in the period.

Seasons, 1884–85.	Mean Pressure.	Mean Temperature.	Mean Daily Range.	Accumulated Temperature.		Rainfall.
				Above 42°.	Below 42°.	
	ins.	°	°	°	°	ins.
Winter	29·95	37·6	9·6	57	503	6·24
Spring	29·93	44·4	16·8	485	247	6·05
Summer	29·97	58·4	17·8	1507	*nil*	3·65
Autumn	29·87	46·6	12·1	534	127	11·88

The following are the notes on each month which, according to my usual custom, I append.

JANUARY.—The coldest January since 1881, with a considerable prevalence of foggy, gloomy weather; snow however only fell on 8th, and to a very slight extent on 13th. *Pressure* 0·18 in. below the mean; highest 30·45 ins. on 1st; lowest 29·16 ins. on 29th. *Temperature* as much as 6°·4 below the mean for the period; warmest day 44°·1 on 28th; coldest day 27°·6 on 22nd; highest in sun 72°·4 on 30th; lowest on grass 21°·1 on 22nd. *Rainfall* 0·24 in. in excess of mean, chiefly owing to the heavy fall on the night of 31st; of the total, 0·98 in. fell during the day and 0·69 in. during the night. *Weather*, a prevalence of F which was dense on the 23rd to 26th. *Prevailing wind*, S.

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FEBRUARY.—A mild but somewhat wet month. By observations taken at Greenwich this month seems to have become milder of late years, the mean temp. of the last 20 years being considerably in excess of the mean temp. of the last 45 years, though the shorter forms part of the longer period. *Pressure* 0·27 in. below the mean; highest 30·18 ins. on 21st; lowest 29·06 ins. on 2nd. *Temperature* 1·8 above the mean, and the warmest Feb. in the period; warmest day 49°·0 on 12th; coldest day 31°·8 on 21st; highest in sun 95°·3 on 12th; lowest on grass 19°·4 on 21st. *Rainfall* 0·11 in. below the mean; of the total, 1·28 in. fell during the day, and 0·87 in. during the night; chief fall other than max., 0·36 in. on 4th. *Weather*, F on 12th and 25th, and slight F on several other occasions, S on 22nd. *Prevailing wind*, S.

MARCH.—A cold dry month. *Pressure* 0·14 in. above the mean, and higher than in any other previous March in the period; highest 30·63 ins. on 14th, the highest point reached during the year; lowest 29·32 ins. on 6th. *Temperature* 1°·5 below the mean, and colder than in the previous month; the daily range of temperature was in some cases considerable, thus on 15th it ranged from 52°·6 to 31°·8, or 20°·8; on 16th from 53°·8 to 31°·9, or 21°·9; on 17th from 55°·3 to 30°·7, or 24°·6; on 20th from 59°·3 to 30°·9, or 28°·4; on 28th from 51°·6 to 29°·9, or 21°·7; on 29th from 59°·6 to 30°·9, or 28°·7; on 31st from 58°·1 to 28°·9, or 29°·2. Warmest day 45°·6 on 4th; coldest day 33°·6 on 10th; highest in sun 107°·9 on 20th; lowest on grass 21°·9 on 23rd. *Rainfall* 0·20 in. below the average; of the total 0·32 in. fell during the day, and 0·49 in. during the night; on 21st 0·25 in. fell in snow during the night, lying all the next day. *Weather* dry and cold, with F on 1st, S on 6th and 21st, no rain between 9th and 20th, and only 0·06 in. on 26th after the snow of 21st. *Prevailing wind*, N.

APRIL.—A fairly warm month with a particularly warm period between 18th and 23rd, to which allusion has already been made. *Pressure* 0·06 in. below the mean, being the lowest mean pressure for April yet observed; highest 30·34 ins. on 19th; lowest 29·27 ins. on 6th. *Temperature* 0°·5 above the average, the temperature of the 20th being higher than on any day in June, 1882, or in July, 1880, namely 72°·1; warmest day 55°·3 on 20th; coldest day 37°·5 on 4th; highest in sun 119°·3 on 20th; lowest on grass 20°·9 on 4th, a very sharp frost for so late in the spring. *Rainfall* 0·70 in. above the average; of the total, 1·01 in. fell during the day, and 1·52 in. during the night. *Weather* showery, with T on 6th, 15th, 16th, and 29th, and H on 6th, 11th, 23rd, and 25th. *Prevailing wind*, N., then S.

MAY.—The coldest and the wettest May in the period. *Pressure* 0·16 in. below the mean, and lower than in any previous year, highest 30·22 ins. on 12th, lowest 29·30 ins. on 7th. *Temperature* 2°·9 below the average, and the lowest mean for the month in the period; warmest day 61°·1 on 28th; coldest day 42°·0 on 12th; highest in sun 124°·5 on 31st; lowest on grass 26°·4 on 12th. *Rainfall* 1·54 in. above the average; the fall occurred

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chiefly in two groups of wet days, namely 3rd to 7th, and 16th to 25th. Of the total, 1·74 in. fell during the day, and 0·97 in. during the night. Chief falls other than max., 0·26 in. on 3rd, 0·25 in. on 20th, 0·28 in. on 22nd, and 0·33 in. on 25th. *Weather* showery and misty, with T on 4th, 5th, 21st, and 23rd, H on 16th, 17th, 18th, and 23rd, and a solar halo on 13th. *Prevailing wind*, N. and N.W.

JUNE.—Not by any means a warm month; though there were some warm days, there were some cold and even frosty nights; for instance, there was a white frost as late as the 18th. *Pressure* 0·08 in. above the average and the highest mean for June in the period; highest 30·45 ins. on 12th; lowest 29·54 ins. on 20th. *Temperature* 0°·2 above the mean; though the day temp. exceeded 80° on 4th, it was no higher than 54° on 25th; warmest day 65°·9 on 4th; coldest day 50°·9 on 11th; highest in sun 132°·0 on 24th; lowest on grass 38°·8 on 11th. *Rainfall* 0·4 in. only in excess of mean; nearly half the whole amount fell on the day of max. fall. Of the total, 1·00 in. fell during the day, and 1·00 in. during the night; of the max. 0·90 in. fell during the day; chief falls other than max., 0·27 in. on 5th, and 0·28 in. on 7th. *Weather* fine, with a fair percentage of sunshine, the only very wet day being the 8th. *Prevailing wind*, S.W.

JULY.—The peculiar dryness of July has already been alluded to. *Pressure* 0·24 in. above the mean, highest 30·45 ins. on 22nd; lowest 29·84 ins. on 18th; the mean was the lowest for July in the period. *Temperature* 0°·4 above the average, and, though it was by no means a hot month, temp. was high on 25th and 26th, on which days it exceeded 84°; highest in sun 133°·0 on 11th; lowest on grass 39°·6 on 24th. *Rainfall* as much as 2·36 ins. below the mean, or about 14% of the average fall. Of this small total 0·22 in. fell during the day, and 0·16 in. during the night. *Weather* bright, with a remarkable absence of anything like electrical disturbances, and with a larger amount of sunshine than in previous years. *Prevailing wind*, N., N.E., and S.W.

AUGUST.—Not a hot month by any means, but very dry; a white frost occurred on the 14th, which left its mark on some of the more tender vegetation. *Pressure* 0·01 in. above the average for the period, highest 30·33 ins. on 15th, lowest 29·59 ins. on 10th. *Temperature* 2°·2 below the average; warmest day 63°·3 on 18th; coldest day 50°·6 on 30th; highest in sun 128°·8 on 17th; lowest on grass 37°·1 on 14th. *Rainfall* 0·83 in. below the average, the rain falling chiefly between 4th and 7th and between 19th and 22nd. *Weather* somewhat cloudy, T on 5th, 6th, and 7th, fresh S.W. breezes 10th, 11th, and 12th. *Prevailing wind*, N.E.

SEPTEMBER.—Cold and very wet, rain falling on all but seven days. *Pressure* 0·04 in. below the mean; highest 30·28 ins. on 22nd; lowest 29·50 ins. on 4th. *Temperature* 1°·5 below the mean; warmest day 65°·8 on 15th; coldest day 41°·4 on 27th, this latter being the coldest day in September yet observed in the period; highest in sun 121°·0 on 3rd; lowest on grass 26°·6 on 26th.

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Rainfall 0·80 in. in excess of mean. Of the total, 0·84 in. fell during the day, and 2·67 ins. during the night, as much as 1·17 of the max. falling after 9 p.m. on 10th. Chief falls other than max., 0·40 in. on 28th, 0·30 in. on 2nd, 0·29 in. on 16th, and 0·27 in. on 8th. *Weather* wet, cold, and cheerless. *Prevailing wind*, S.

October.—Cold and wet, being the wettest October since 1882. *Pressure* 0·21 in. below the average, and the lowest mean pressure yet observed for October; highest 30·18 ins. on 17th; lowest 29·01 ins. on 10th, the minimum pressure for the year. *Temperature*, 2°·5 below the average, and the lowest mean temp. since 1881; warmest day 52°·4 on 4th; coldest day 38°·3 on 30th; highest in sun 108°·9 on 1st; lowest on grass 28°·8 on 12th; the first trace of frost being on the 8th. *Rainfall* 1·46 in. above the mean. Of the total, 2·27 ins. fell during the day, and 2·64 ins. during the night; chief falls other than max. 0·72 in. on 6th, 0·43 in. on 13th, and also on 14th, 0·42 in. on 31st, 0·37 in. on 4th, 0·34 in. on 30th, and 0·26 in. on 8th. *Weather* unsettled, **F** dense on 18th, and slight on other occasions. *Prevailing wind*, S.W.

November.—Another cold wet month, making the autumn the coldest and the wettest in the period. *Pressure* 0·08 in. above the mean, highest 30·39 ins. on 16th; lowest 29·22 ins. on 28th. *Temperature* 0°·6 below the average; warmest day 48°·7 on 30th; coldest day 32°·8 on 18th; highest in sun 90°·2 on 2nd; lowest on grass 25°·1 on 6th. *Rainfall* 0·86 in. in excess, being the greatest fall for the month in the period; of the total, 1·96 in. fell during the day, and 1·50 in. during the night. Chief falls other than max., 0·35 in. on 4th, 0·34 in. on 25th, 0·33 in. on 3rd, 0·29 in. on 5th, 0·27 in. on 29th and on 30th, 0·26 in. on 27th, and 0·25 in. on 24th. *Weather* dull and unsettled, **F** very prevalent, being dense on 25th and 26th. *Prevailing wind*, N.E. and S.E.

December.—A particularly dry month, with a rainfall scarcely exceeding that of March. *Pressure* 0·12 in. above the average, highest 30·58 ins. on 23rd; lowest 29·51 ins. on 6th. *Temperature* 1°·2 below the average, and the lowest mean in the period; warmest day 46°·4 on 1st; coldest day 27°·2 on 11th; highest in sun 83°·4 on 3rd; instrument on grass out of order. *Rainfall* very small, being 1·44 in. below the mean; the driest December in the period; of the total 0·32 in. fell during the day and 0·50 in. during the night. *Weather* dry and cold, **S** on 7th, and 9th, which lay until 12th, then a prevalence of **F**, which was dense on the 18th, 19th, and 25th; **S** again on 29th and 30th. *Prevailing wind*, S.W. and N.

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VIII.

REPORT ON THE RAINFALL IN HERTFORDSHIRE IN 1885.

By the Rev. C. W. Harvey, M.A., F.R.Met.Soc.

Read at Hertford, 29th April, 1886.

An Annual Report upon the Rainfall in our County seems to have become a recognised part of the published Transactions of our Society. When we turn to page 63 of the first volume of the 'Transactions of the Watford Natural History Society,' we find a record of the rainfall for the first three months of the year 1875 at three stations; this is followed on page 112 of the same volume by a brief, one-page report, on the rainfall for the whole of the same year, giving the fall at four stations in the Lower Colne District, and at one in the District of the Bulborne. For the year 1876 Mr. Hopkinson published what may be considered the first regular report on the rainfall throughout the County, giving the results of observations at twenty-two stations. The present report will, therefore, form the tenth consecutive one which has been laid before the Society, the first four (1876-1879) having been prepared by Mr. Hopkinson, the last six (1880-1885) by myself. It may not be uninteresting therefore to record the progress during that period, as regards the number of stations, and gauges at work, each year:

Year.	Stations.	Gauges.	Year.	Stations.	Gauges.
1876	22	23	1881	29	31
1877	26	27	1882	29	31
1878	26	27	1883	29	33
1879	27	28	1884	27	31
1880	27	28	1885	26	29

On the whole these numbers are satisfactory, and show no signs of any flagging of interest in this particular branch of meteorology. It is true that since 1883 there has been a slight yearly decrease in the number of observers, but the decrease does not arise from any real loss of interest. Last year it may be remembered I had to record the retirement of the Rev. J. O. Seager, of Stevenage, an observer of 15 years' standing; this year I am sorry to have to record the loss, by death, of an observer of nearly 37 years' standing in the person of Mr. W. Squire, of Great Berkhamsted. But the Berkhamsted record has not thus been brought abruptly to an end; another observer, well known among meteorologists, has commenced observations there during the year, namely Mr. E. Mawley, a vice-president of the Royal Meteorological Society, and the author of a well-known annual report on the weather in the neighbourhood of London.

Our Reports, therefore, extending as they now do over a complete decade (1876-85), I have thought it well to draw out a fresh set of

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Table I.—Hertfordshire Rainfall Stations.

River District.	Station.	Observer.	Latitude.	Longitude.	Diameter of Gauge.	Height of Gauge above Ground.	Height of Gauge above Sea-level.	
			° ′ ″	° ′ ″	ins.	ft. ins.	ft.	
Thame — Up. Thame	Tring—The Vicarage	Rev. W. Quennell	51 47 33 N	0 39 25 W	5	1 0	442	T
Thame — Lower Colne	Watford—Watford House	Alfred T. Brett, M.D.	51 39 25 N	0 23 35 W	5	1 0	240	T
Thame — Lower Colne	,, Wansford House	John Hopkinson	51 39 45 N	0 23 40 W	5	1 0	224	T
Thame — Lower Colne	Rickmansworth—Moor Park	Lord Ebury	51 37 30 N	0 26 20 W	5	2 0	340	⋀
Colne — Ver	St. Albans—Gorhambury	The Earl of Verulam	51 45 20 N	0 23 0 W	6	2 6	425	
Colne — Ver	Harpenden—Rothamsted	Sir J. B. Lawes and Dr. Gilbert	51 48 10 N	0 21 30 W	5	0 9	420	T
Colne — Ver	,, ,, (2nd gauge)	Sir J. B. Lawes and Dr. Gilbert	51 48 10 N	0 21 30 W	72 × 87	0 9	420	T
Colne — Ver	,, ,, (3rd gauge)	Sir J. B. Lawes and Dr. Gilbert	51 48 10 N	0 21 30 W	8	0 9	420	T
Colne — Ver	Kensworth	Miss Grace Jones	51 51 30 N	0 30 0 W	5	1 5	630	B
Colne — Gade and Bulbourne	Hemel Hempsted—Nash Mills	J. Dickinson & Co.	51 44 0 N	0 26 40 W	12	3 9	237	T
Colne — Gade and Bulbourne	,, Great Gaddesden	Rev. W. T. Drake	51 47 20 N	0 30 30 W	8	1 0	426	⋀
Colne — Gade and Bulbourne	Berkhamsted	Edward Mawley	51 45 40 N	0 33 30 W	8	1 0	401	⋀
Colne — Gade and Bulbourne	Tring—Cowroast	Hubert Thomas, C.E.	51 47 0 N	0 36 30 W	10	4 2	345	L
Lea — Lower Lea	East Barnet—Southgate	G. A. Church	51 37 40 N	0 8 0 W	5	0 6	240	T
Lea — Upper Lea	Ware—New River Company	F. Francis, C.E.	51 46 0 N	0 6 0 W	12	3 0	114	T
Lea — Upper Lea	,, Fanhams Hall	Miss J. Croft	51 49 30 N	0 1 30 W	8	1 0	253	
Lea — Upper Lea	Hertford—Bayfordbury	W. Clinton Baker	51 46 30 N	0 5 30 W	8	0 4	250	
Lea — Mimram	Welwyn—The Rectory	Rev. C. L. Wingfield	51 49 50 N	0 12 30 W	5	0 4	228	T
Lea — Mimram	,, Datchworth	Rev. J. Wardale	51 51 0 N	0 10 0 W	6	1 0	386	T
Lea — Beane	Stevenage—Bennington	Rev. J. D. Parker, LL.D.	51 53 45 N	0 5 20 W	5	1 0	480	⋀
Lea — Beane	,, Knebworth	Rev. F. G. Jenyns	51 52 30 N	0 12 30 W	5	1 0	391	⋀
Lea — Rib	Buntingford—Throcking	Rev. C. W. Harvey	51 57 5 N	0 3 0 W	5	1 0	484	T
Lea — Rib	Royston—Therfield	Rev. J. G. Hale	52 1 0 N	0 3 0 W	5	4 3	500	
Lea — Ash	Ware—Much Hadham	T. W. Mott	51 51 24 N	0 4 38 E	5	1 0	222	B
Cam. Ivel. — Hiz	Hitchin	William Lucas	51 57 0 N	0 16 20 W	5	2 1	238	⋀
Cam. Ivel. — Hiz	,, High Down	Joseph Pollard	51 57 40 N	0 20 0 W	5	1 1	422	⋀
Cam. Ivel. — Rhee	Royston	H. Wortham	52 2 34 N	0 1 8 W	8	0 6	269	⋀
Cam. Ivel. — Rhee	,, Odsey Grange	H. G. Fordham	52 1 28 N	0 6 41 W	5	1 0	263	⋀
Cam. Ivel. — Rhee	,, ,, ,,	,, ,,	52 1 28 N	0 6 41 W	5	1 0	263	⋀

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TABLE II.—RAINFALL AT VARIOUS STATIONS IN HERTFORDSHIRE IN 1884.

STATIONS.	JAN.	FEB.	MAR.	APL.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL.	DAYS.
Tring—The Vicarage	2·99	3·23	1·67	2·25	3·02	1·85	·50	1·58	4·40	5·34	4·23	1·20	32·26	189
Watford—Watford House ...	2·60	2·67	1·56	2·44	2·73	1·91	·21	1·09	4·13	3·64	3·16	1·08	27·22	172
,, Wansford House...	3·05	3·02	1·80	2·65	3·04	1·92	·32	1·10	4·10	4·14	3·69	1·19	30·02	183
Rickmansworth—Moor Park	2·84	3·72	1·70	2·50	2·84	2·03	·27	1·01	4·58	4·12	3·59	1·18	30·38	176
St. Albans—Gorhambury ...	3·13	3·88	1·51	2·73	2·99	2·95	·36	1·56	4·47	4·69	3·51	1·26	33·04	163
Harpenden—Rothamsted.....	2·94	2·84	1·19	2·81	2·82	2·71	·35	1·56	4·31	4·72	3·73	1·21	31·19	168
,, ,, (2nd gauge)	2·99	2·85	1·46	2·88	2·88	2·76	·38	1·59	4·39	4·82	3·77	1·33	32·10	183
,, ,, (3rd gauge)	2·88	2·73	1·29	2·77	2·73	2·68	·35	1·52	4·19	4·64	3·65	1·20	30·63	160
Kensworth.....	2·56	3·12	1·49	2·44	2·43	2·47	·21	1·65	4·44	4·94	3·63	1·22	30·60	149
Hemel Hempsted—Nash Mills	3·00	3·15	1·72	2·32	3·49	2·16	·38	1·23	4·46	4·50	3·90	1·25	31·56	150
,, Great Gaddesden	2·61	2·98	1·34	2·36	3·22	1·91	·32	1·35	3·70	5·24	3·66	1·22	29·91	178
Berkhamsted	2·87	3·16	1·48	1·98	2·95	1·70	·40	1·31	3·99	5·07	3·74	1·12	29·77	180
Tring—Cowroast	3·03	3·01	1·44	2·32	2·93	1·80	·60	1·37	4·62	5·47	3·97	1·15	31·71	149
East Barnet—Southgate	1·82	2·87	1·67	2·96	2·70	1·88	·29	1·53	3·99	4·13	3·58	1·57	28·99	171
Ware—New River Company	1·88	2·57	1·02	2·12	2·40	2·04	·51	1·42	3·53	4·25	3·04	1·01	25·79	164
,, Fanhams Hall.....	2·41	2·72	1·09	2·13	2·66	2·35	·78	1·64	3·75	4·63	3·18	1·06	28·40	168
Hertford—Bayfordbury	1·87	2·74	1·17	2·12	2·50	2·07	·64	1·58	4·07	4·18	3·55	1·11	27·60	171
Welwyn—The Rectory	2·64	2·47	1·10	2·27	2·61	2·30	·19	1·78	4·35	4·90	3·76	1·19	29·56	180
,, Datchworth	2·24	2·36	·97	2·38	2·25	2·10	·24	1·55	4·31	4·89	3·71	1·01	28·01	171
Stevenage—Bennington	2·24	2·20	·86	2·66	2·59	2·02	·26	1·91	3·59	4·95	3·56	·89	27·73	184
,, Knebworth	2·65	2·29	1·05	2·36	2·24	1·98	·32	2·13	4·10	5·42	3·70	1·05	29·29	174
Buntingford—Throcking.....	1·67	2·15	·81	2·53	2·71	2·00	·38	1·27	3·51	4·91	3·46	·82	26·22	169
Royston—Therfield	1·72	1·92	·94	2·37	3·30	2·26	·46	1·77	3·85	4·91	3·36	·89	27·75	158
Ware—Much Hadham.....	1·99	2·87	1·12	2·08	2·98	2·76	·66	1·29	3·70	4·66	3·32	1·09	28·52	170
Hitchin	2·25	2·20	1·12	2·68	2·51	2·63	·10	2·39	3·86	4·99	3·40	·77	28·90	166
,, High Down	1·63	2·51	1·10	2·85	2·61	2·34	·30	2·12	3·69	4·94	3·50	1·67	29·26	168
Royston	1·63	1·89	·96	2·12	2·76	1·27	·21	2·06	3·15	4·39	3·06	·89	24·39	159
,, Odsey Grange.....	1·47	1·62	·95	2·22	2·87	2·21	·43	1·65	3·78	4·16	2·65	·78	24·79	174
,, ,, (2nd gauge)...	1·69	1·67	·97	2·33	3·12	2·25	·43	1·64	3·75	3·93	2·79	·70	25·27	173
Mean for the County	2·39	2·67	1·26	2·44	2·79	2·18	·37	1·57	4·03	4·68	3·51	1·11	29·00	170

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Table I.—Hertfordshire Rainfall Stations.

River District.	Station.	Observer.	Latitude.	Longitude.	Diameter of Gauge.	Height of Gauge above Ground.	Height of Gauge above Sea-level.
			° ′ ″	° ′ ″	ins.	ft. ins.	ft.
Thame — Up. Thame	Tring—The Vicarage	Rev. W. Quennell	51 47 33 N	0 39 25 W	5	1 0	442 T
Colne — Lower Colne	Watford—Watford House	Alfred T. Brett, M.D.	51 39 25 N	0 23 35 W	5	1 0	240 T
	,, Wansford House	John Hopkinson	51 39 45 N	0 23 40 W	5	1 0	224 T
	Rickmansworth—Moor Park	Lord Ebury	51 37 30 N	0 26 20 W	5	2 0	340 ⅄
Colne — Ver	St. Albans—Gorhambury	The Earl of Verulam	51 45 20 N	0 23 0 W	6	2 6	425
	Harpenden—Rothamsted	Sir J. B. Lawes and Dr. Gilbert	51 48 10 N	0 21 30 W	5	0 9	420 T
	,, ,, (2nd gauge)		51 48 10 N	0 21 30 W	72 × 87	0 9	420 T
	,, ,, (3rd gauge)		51 48 10 N	0 21 30 W	8	0 9	420 T
	Kensworth	Miss Grace Jones	51 51 30 N	0 30 0 W	5	1 5	630 B
Colne — Gade and Bulbourne.	Hemel Hempsted—Nash Mills	J. Dickinson & Co.	51 44 0 N	0 26 40 W	12	3 9	237 T
	,, Great Gaddesden	Rev. W. T. Drake	51 47 20 N	0 30 30 W	8	1 0	426 ⅄
	Berkhamsted	Edward Mawley	51 45 40 N	0 33 30 W	8	1 0	401 ⅄
	Tring—Cowroast	Hubert Thomas, C.E.	51 47 0 N	0 36 30 W	10	4 2	345 L
Lea — Lower Lea	East Barnet—Southgate	G. A. Church	51 37 40 N	0 8 0 W	5	0 6	240 T
Lea — Upper Lea	Ware—New River Company	F. Francis, C.E.	51 46 0 N	0 6 0 W	12	3 0	114 T
	,, Fanhams Hall	Miss J. Croft	51 49 30 N	0 1 30 W	8	1 0	253
Lea — Mimram	Hertford—Bayfordbury	W. Clinton Baker	51 46 30 N	0 5 30 W	8	0 4	250
	Welwyn—The Rectory	Rev. C. L. Wingfield	51 49 50 N	0 12 30 W	5	0 4	228 T
	,, Datchworth	Rev. J. Wardale	51 51 0 N	0 10 0 W	6	1 0	386 ⅄
Lea — Beane	Stevenage—Bennington	Rev. J. D. Parker, LL.D.	51 53 45 N	0 5 20 W	5	1 0	480 ⅄
	,, Knebworth	Rev. F. G. Jenyns	51 52 30 N	0 12 30 W	5	1 0	391 ⅄
Lea — Rib	Buntingford—Throcking	Rev. C. W. Harvey	51 57 5 N	0 3 0 W	5	1 0	484 T
	Royston—Therfield	Rev. J. G. Hale	52 1 0 N	0 3 0 W	5	4 3	500
Lea — Ash	Ware—Much Hadham	T. W. Mott	51 51 24 N	0 4 38 E	5	1 0	222 B
Cam. Ivel. — Hiz	Hitchin	William Lucas	51 57 0 N	0 16 20 W	5	2 1	238 ⅄
	,, High Down	Joseph Pollard	51 57 40 N	0 20 0 W	5	1 1	422 ⅄
Cam. Ivel. — Rhee	Royston	H. Wortham	52 2 34 N	0 1 8 W	8	0 6	269 ⅄
	,, Odsey Grange	H. G. Fordham	52 1 28 N	0 6 41 W	5	1 0	263 ⅄
	,, ,, ,,	,, ,,	52 1 28 N	0 6 41 W	5	1 0	263 ⅄

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TABLE II.—RAINFALL AT VARIOUS STATIONS IN HERTFORDSHIRE IN 1884.

STATIONS.	JAN.	FEB.	MAR.	APL.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL.	DAYS.
Tring—The Vicarage	2·99	3·23	1·67	2·25	3·02	1·85	·50	1·58	4·40	5·34	4·23	1·20	32·26	189
Watford—Watford House ...	2·60	2·67	1·56	2·44	2·73	1·91	·21	1·09	4·13	3·64	3·16	1·08	27·22	172
,, Wansford House...	3·05	3·02	1·80	2·65	3·04	1·92	·32	1·10	4·10	4·14	3·69	1·19	30·02	183
Rickmansworth—Moor Park	2·84	3·72	1·70	2·50	2·84	2·03	·27	1·01	4·58	4·12	3·59	1·18	30·38	176
St. Albans—Gorhambury ...	3·13	3·88	1·51	2·73	2·99	2·95	·36	1·56	4·47	4·69	3·51	1·26	33·04	163
Harpenden—Rothamsted.....	2·94	2·84	1·19	2·81	2·82	2·71	·35	1·56	4·31	4·72	3·73	1·21	31·19	168
,, ,, (2nd gauge)	2·99	2·85	1·46	2·88	2·88	2·76	·38	1·59	4·39	4·82	3·77	1·33	32·10	183
,, ,, (3rd gauge)	2·88	2·73	1·29	2·77	2·73	2·68	·35	1·52	4·19	4·64	3·65	1·20	30·63	160
Kensworth.....	2·56	3·12	1·49	2·44	2·43	2·47	·21	1·65	4·44	4·94	3·63	1·22	30·60	149
Hemel Hempsted—Nash Mills	3·00	3·15	1·72	2·32	3·49	2·16	·38	1·23	4·46	4·50	3·90	1·25	31·56	150
,, Great Gaddesden	2·61	2·98	1·34	2·36	3·22	1·91	·32	1·35	3·70	5·24	3·66	1·22	29·91	178
Berkhamsted	2·87	3·16	1·48	1·98	2·95	1·70	·40	1·31	3·99	5·07	3·74	1·12	29·77	180
Tring—Cowroast	3·03	3·01	1·44	2·32	2·93	1·80	·60	1·37	4·62	5·47	3·97	1·15	31·71	149
East Barnet—Southgate	1·82	2·87	1·67	2·96	2·70	1·88	·29	1·53	3·99	4·13	3·58	1·57	28·99	171
Ware—New River Company	1·88	2·57	1·02	2·12	2·40	2·04	·51	1·42	3·53	4·25	3·04	1·01	25·79	164
,, Fanhams Hall.....	2·41	2·72	1·09	2·13	2·66	2·35	·78	1·64	3·75	4·63	3·18	1·06	28·40	168
Hertford—Bayfordbury	1·87	2·74	1·17	2·12	2·50	2·07	·64	1·58	4·07	4·18	3·55	1·11	27·60	171
Welwyn—The Rectory	2·64	2·47	1·10	2·27	2·61	2·30	·19	1·78	4·35	4·90	3·76	1·19	29·56	180
,, Datchworth	2·24	2·36	·97	2·38	2·25	2·10	·24	1·55	4·31	4·89	3·71	1·01	28·01	171
Stevenage—Bennington	2·24	2·20	·86	2·66	2·59	2·02	·26	1·91	3·59	4·95	3·56	·89	27·73	184
,, Knebworth	2·65	2·29	1·05	2·36	2·24	1·98	·32	2·13	4·10	5·42	3·70	1·05	29·29	174
Buntingford—Throcking.....	1·67	2·15	·81	2·53	2·71	2·00	·38	1·27	3·51	4·91	3·46	·82	26·22	169
Royston—Therfield	1·72	1·92	·94	2·37	3·30	2·26	·46	1·77	3·85	4·91	3·36	·89	27·75	158
Ware—Much Hadham.....	1·99	2·87	1·12	2·08	2·98	2·76	·66	1·29	3·70	4·66	3·32	1·09	28·52	170
Hitchin	2·25	2·20	1·12	2·68	2·51	2·63	·10	2·39	3·86	4·99	3·40	·77	28·90	166
,, High Down	1·63	2·51	1·10	2·85	2·61	2·34	·30	2·12	3·69	4·94	3·50	1·67	29·26	168
Royston	1·63	1·89	·96	2·12	2·76	1·27	·21	2·06	3·15	4·39	3·06	·89	24·39	159
,, Odsey Grange.....	1·47	1·62	·95	2·22	2·87	2·21	·43	1·65	3·78	4·16	2·65	·78	24·79	174
,, ,, (2nd gauge)...	1·69	1·67	·97	2·33	3·12	2·25	·43	1·64	3·75	3·93	2·79	·70	25·27	173
Mean for the County	2·39	2·67	1·26	2·44	2·79	2·18	·37	1·57	4·03	4·68	3·51	1·11	29·00	170

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mean values based upon these years, with which to compare the rainfall of the year. In the present Report, therefore, the terms "mean" and "average" will refer to the above ten years. The mean fall for the ten years appears to be 29·00 inches, and the mean number of wet days, 170, the fall being dispersed throughout the months as follows:

Jan.	2·03	April	2·26	July	2·53	Oct.	2·78
Feb.	2·45	May	1·95	Aug.	2·76	Nov.	2·70
Mar.	1·53	June	2·43	Sept.	2·91	Dec.	2·67

It will be seen by the present report that the year 1885, as regards both the year's actual fall, and the number of days on which rain fell, agrees *exactly* with this ten-year mean.

Thus much by way of preface to the tenth report on the rainfall. I now proceed to the consideration of the rainfall of the year 1885, in doing which I shall follow the lines laid down in previous reports.

The most striking feature in the rainfall of the year is undoubtedly the extreme dryness of July. The mid-summer month is as a rule a somewhat wet month, owing in a great measure to the frequent recurrence of heavy thunder showers; in the present year it has been the driest July since 1868, and the driest month in the year. On the other hand, September was a particularly wet month, the wettest September since 1876. Of this wet month Sept. 10th proved a very wet day, the fall at all stations exceeding an inch, ranging from 1·87 inch at Moor Park, to 1·09 at Hadham, the average at all stations being 1·41 inch. Comparing the rainfall in our own county with that of the neighbouring counties of Norfolk and Essex, we find that whilst our own mean rainfall has been 29 inches, that of Norfolk has been less (28·74), and that of Essex considerably less (24·78), whilst the fall in the more western county of Wilts has naturally been greater (31·41).

Distribution of Rainfall throughout the Year.—A dry summer was succeeded by a wet autumn; indeed, whilst the rainfall of the summer months only represented 14°/₀, that of the autumn months represented 42°/₀ of the total fall. I give the fall of each quarter, and of each season, showing how far it differs from the average fall.

	Fall.	Diff.		Fall.	Diff.
1st quarter	6·32 in.	+ ·31 in.	Winter	6·17 in.	— ·98 in.
2nd ,,	7·41	+ ·77	Spring	6·49	+ ·75
3rd ,,	5·97	—2·23	Summer	4·12	—3·60
4th ,,	9·30	+1·15	Autumn	12·22	+3·83
Year	29·00	=		29·00	=

When we compare the mean monthly fall for 1885 with the ten-year average, we find that, next to July, December was decidedly the driest month, whilst, although September was wet, October showed a still greater departure from the mean.

	in.		in.		in.		in.
Jan.	+ ·36	April	+ ·18	July	−2·13	Oct.	+1·90
Feb.	+ ·22	May	+ ·84	Aug.	—1·19	Nov.	+ ·81
Mar.	— ·27	June	— ·25	Sept.	+1·12	Dec.	—1·56

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Table III.—Mean Monthly Fall in the River Districts.

Month.	Thame.			Colne.			Lea.			Ivel.			Cam.		
	1876–85.	1885.	Diff. 1885.	1876–85.	1885.	Diff. 1885.	1876–85.	1885.	Diff. 1885.	1876–85.	1885.	Diff. 1885.	1876–85.	1885.	Diff. 1885.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	2·36	2·99	+0·63	2·27	2·87	+0·60	1·88	2·11	+0·23	1·80	1·94	+0·14	1·55	1·60	+0·05
February	2·84	3·23	+0·39	2·72	3·09	+0·37	2·32	2·47	+0·15	2·19	2·36	+0·17	1·93	1·73	−0·20
March	1·68	1·67	−0·01	1·67	1·50	−0·17	1·46	1·07	−0·39	1·28	1·11	−0·17	1·16	0·96	−0·20
April	2·32	2·25	−0·07	2·56	2·52	−0·04	2·19	2·36	+0·17	2·30	2·76	+0·46	1·96	2·22	+0·26
May	2·20	3·02	+0·82	2·11	2·92	+0·81	1·82	2·63	+0·81	1·83	2·56	+0·73	1·71	2·92	+1·21
June	2·34	1·85	−0·49	2·64	2·25	−0·39	2·25	2·16	−0·09	2·16	2·49	+0·33	2·33	1·91	−0·42
July	2·72	0·50	−2·22	2·54	0·35	−2·19	2·50	0·43	−2·07	2·60	0·20	−2·40	2·16	0·36	−1·80
August	2·83	1·58	−1·25	3·19	1·36	−1·83	2·69	1·62	−1·07	2·68	2·25	−0·43	2·54	1·78	−0·76
September	3·28	4·40	+1·12	2·82	4·28	+1·46	2·71	3·89	+1·18	2·88	3·78	+0·90	2·49	3·56	+1·07
October	3·11	5·34	+2·23	2·95	4·67	+1·72	2·66	4·71	+2·05	2·58	4·96	+2·38	2·32	4·16	+1·84
November	3·45	4·23	+0·78	3·05	3·67	+0·62	2·89	3·48	+0·59	2·79	3·45	+0·66	2·34	2·83	+0·49
December	2·77	1·20	−1·57	2·78	1·20	−1·58	2·33	1·06	−1·27	2·21	1·22	−0·99	2·01	0·79	−1·22
Year	31·90	32·26	+0·36	31·30	30·68	−0·62	27·70	27·99	+0·29	27·30	29·08	+1·78	24·50	24·82	+0·32

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Distribution of Rainfall throughout the County.—In the two main River Basins of the THAMES and the OUSE the rainfall in the former was just equal to the ten-year mean, whilst in the latter it somewhat exceeded it. In the five districts of the Thame, Colne, Lea, Ivel, and Cam, three out of the five differed very little from the mean, and the Colne alone showed a deficiency, the Ivel on the other hand showing the greatest excess. In the minor River Districts the Upper Thame again experienced the largest rainfall, and the Rhee the smallest, others following the distribution of last year in this respect. The mean fall in each of these districts was—

		ins.			ins.
LEA	Lower Lea	28·99	THAME	Upper Thame	32·26
	Upper Lea	27·26	COLNE	Lower Colne	29·21
	Mimram	28·79		Ver	31·51
	Beane	28·51		Gade	30·74
	Rib	26·98	IVEL	Hiz	29·08
	Ash	28·52	CAM	Rhee	24·82

The maximum yearly fall was 32·26 ins. at Tring, the minimum being 24·39 ins. at Royston. The greatest monthly fall was 5·47 ins. in October at Cowroast, and the least 0·10 inch in July at Hitchin. This is the smallest monthly fall of which I can find any record, except 0·08 inch at Cassiobury in April, 1870. In February, 1857, the fall at Hitchin was only 0·11 inch; in July, 1868, only 0·14 fell at Hadham; and in July, 1864, only 0·17 fell at Hitchin.

The absolute maximum fall in each month and the station at which it occurred was:—

	in.		in.
Jan. 10th—Nash Mills	1·03	July 7th—Fanhams Hall	0·49
Feb. 4th—Gorhambury	0·97	Aug. 5th—Royston	0·83
Mar. 15th—Nash Mills	0·74	Sept. 10th—Moor Park	1·87
Apr. 28th—Rothamsted	0·98	Oct. 23rd—Tring	1·31
May 21st—Wansford House	0·73	Nov. 24th—Southgate	0·80
June 8th—Gorhambury *	1·44	Dec. 25th—High Down	0·61

The maximum fall of the year was therefore 1·87 in. on Sept. 10th at Moor Park, the heaviest fall since June, 1883. At all stations the 10th was an exceedingly wet day, no one station recording less than an inch. The wettest days in each month were—

January 10th the wettest at 2 stations; 31st at 24.
February 4th at 3; 16th at 23.
March 3rd at 20; 21st at 5; the fall at 1 on 3rd and 21st being the same.
April 15th at 22; 23rd at 2; 27th at 1; 28th at 1.
May 20th at 2; 21st at 22; 22nd at 2.
June 7th at 2; 8th at 24.
July 7th at 1; 11th at 12; 12th at 3; 13th at 4; 19th at 4; 20th at 1; the fall at 1 on 11th and 12th being the same.
August 4th at 5; 5th at 4; 6th at 4; 7th at 2; 12th at 3; 26th at 7; the fall at 1 on 4th and 26th being the same.
September 10th at all stations.
October 6th at 2; 23rd at 24.
November 3rd at 4; 24th at 2; 25th at 2; 26th at 17; 30th at 1.
December 25th at 1; 28th at 4; 30th at 18; the fall on 28th and 30th being the same at 2, and on 5th and 30th at 1 station.

* The same amount was gauged at Hitchin.

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From this analysis we find that the wettest day in each month was—

Jan. 31st.	Apr. 15th.	July 11th.	Oct. 23rd.
Feb. 16th.	May 21st.	Aug. 26th.	Nov. 26th.
Mar. 3rd.	June 8th.	Sept. 10th.	Dec. 30th.

The mean number of wet days in each month, and the relation which that number bears to the mean, appears to be—

Jan.	wet days	15 or 1 below mean.	July	wet days	5 or 8 below mean.
Feb.	,,	18 or 3 above ,,	Aug.	,,	11 or 3 below ,,
Mar.	,,	7 or 7 below ,,	Sept.	,,	20 or 7 above ,,
Apr.	,,	15 or 2 above ,,	Oct.	,,	19 or 5 above ,,
May	,,	17 or 4 above ,,	Nov.	,,	18 or 2 above ,,
June	,,	11 or 3 below ,,	Dec.	,,	14 or 1 below ,,

Out of a total of 170 wet days, only 27 occurred during the summer months, or 14 days less than the average; whilst 57 occurred in the autumn months, or 14 above the average; thus we had a fortnight more of dry weather than usual during the summer, which, however, was counterbalanced by an extra fortnight of wet in the autumn.

I shall now proceed to notice briefly the general characteristics of the weather of each month, noticing every fall of half an inch and upwards, and using the same terms as in my previous report, namely, falls of ½ inch *considerable*; falls of ¾ inch *very considerable*; falls of 1 inch *great*; falls of 1¼ inch *very great*; falls of 1½ inch *heavy*; falls of 1¾ inch *very heavy*; falls of 2 inches *excessive*. I have to thank 19 out of our 26 observers for having again furnished me with a record of the daily fall at their stations, thus enabling me to supply these details.

JANUARY.—The month divides itself into four periods of alternately dry and wet weather; thus 1st-7th, and 16th-25th were dry, whilst 8th-15th, and 26th to end of month were wet. On the 10th the fall was appreciable at all stations, and could almost be called considerable at some. At Nash Mills it was *great*, 1·03 inch. On 31st, the wettest day at all but two stations, the fall was *very considerable* at Wansford House, 0·88, Berkhamsted, 0·86, Nash Mills, 0·85, Gorhambury, 0·82, Moor Park and Rothamsted, 0·78, and Watford House, 0·76; it was *considerable* at Cowroast, 0·73, Welwyn, 0·66, Knebworth, 0·63, Tring and Throcking, 0·62, Bennington, 0·61, Great Gaddesden and Therfield, 0·60, Datchworth and Hitchin, 0·59, Kensworth, 0·54, and Bayfordbury, 0·51. Slight snow fell between 12th and 16th. No rain fell upon the 1st or 6th, and 7th to 24th was an absolutely dry period; at Bennington alone 0·01 fell on 7th and again on 24th.

FEBRUARY.—A somewhat unsettled month, but with one or two short dry periods; thus 9th to 13th, and 18th to 20th were dry at most stations, 11th-13th being absolutely dry at all. On 4th the fall was *very considerable* at Gorhambury, 0·97; on 16th, when max. fell at most stations, it was *considerable* at Hadham, 0·74, Southgate, 0·69, Moor Park, 0·66, Kensworth, 0·65, Watford House, Fanhams Hall, and Ware (N.R.C.), 0·64, Bayfordbury, 0·63, Bennington,

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0·56, Tring and Knebworth, 0·53, Wansford House, 0·52, Throcking, 0·51, and Cowroast and Hitchin (High Down), 0·50.

MARCH.—A dry month, no rain at all falling between 9th and 16th, or after 27th, and the other falls being small, with the exception of 3rd and 21st, on which latter day the fall of snow was considerable. On 3rd the fall was *considerable* at Tring and Southgate, 0·72, Wansford House and Nash Mills, 0·66, Gorhambury and Berkhamsted, 0·65, Moor Park and Cowroast, 0·64, Kensworth, 0·62, Watford House and Rothamsted, 0·59, Bayfordbury, 0·56, Great Gaddesden and Welwyn, 0·55, Hitchin (High Down), 0·53, and Hadham, 0·50. On 21st the fall of snow was *very considerable* at Nash Mills, 0·76; *considerable* at Wansford House, 0·70, Southgate, 0·65, Watford House, 0·64, Tring, 0·61, and Great Gaddesden and Welwyn, 0·56.

APRIL.—A wet month, not more than three or four days at a time being without rain. On 15th the fall was *very considerable* at Bayfordbury, 0·90, Hitchin (High Down), 0·81, Welwyn, Datchworth, and Fanhams Hall, 0·80, and Southgate, Bennington, and Knebworth, 0·78; *considerable* at Great Gaddesden, 0·75, Nash Mills, 0·74, Wansford House, 0·72, Berkhamsted, 0·71, Rothamsted, Cowroast, and Ware (N.R.C.), 0·70, Hitchin, 0·69, Kensworth, 0·68, Watford House and Moor Park, 0·67, Tring, 0·58, Odsey, 0·57, and Throcking, 0·51. On 23rd the fall was *considerable* at Southgate, 0·68. On 28th it was *very considerable* at Rothamsted, 0·98; *considerable* at Gorhambury, 0·73, Southgate, 0·63, Wansford House, 0·56, and Watford House, 0·50.

MAY.—The present was the wettest May since 1879, the fall consisting in a great measure of cold showers, with hail and on 7th snow. The 8th to 15th was however a dry period, no rain falling at any station between 10th and 12th, and at very few on any other day in the period. On 3rd the fall was *considerable* at Therfield, 0·58. On 20th it was *considerable* at Gorhambury, 0·66, Moor Park, 0·62, Nash Mills, 0·57, and Wansford House, 0·50. On 21st, the day of max. fall at most stations, it was *considerable* at Wansford House, 0·73, Nash Mills, 0·68, Tring, Watford House and Hadham, 0·67, Cowroast, 0·66, Bayfordbury, 0·65, Royston, 0·62, Hitchin, 0·61, Berkhamsted, Welwyn, and Datchworth, 0·60, Throcking and Hitchin (High Down), 0·59, Knebworth, 0·58, Odsey, 0·56, Bennington, 0·54, Fanhams Hall, 0·53, Southgate, 0·51, and Rothamsted, 0·50. The fall was also probably considerable at Great Gaddesden, but the gauge was not emptied until the morning of 23rd, when the amount was 0·88 for the two days. On 22nd the fall was *considerable* at Therfield, 0·64.

JUNE.—A bright fine month. Had it not been for the heavy fall of 8th, the rainfall would have been considerably below the average. Nearly all fell between 5th and 8th, and between 16th and 24th. On 5th the fall was *considerable* at Hadham, 0·51, and Kensworth and Cowroast, 0·50. On 7th it was *considerable* at Rothamsted, 0·57, Wansford House, 0·52, and Watford House, 0·50. On 8th, the day of max. fall at all but two stations, it was *very great* at

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Gorhambury and Hitchin, 1·44, Hadham, 1·38, and Rothamsted, 1·29; *great* at Therfield, 1·20, Royston, 1·16, Odsey, 1·15, Hitchin (High Down), 1·11, Bayfordbury, 1·02, and Datchworth, 1·01; *very considerable* at Kensworth and Welwyn, 0·95, Throcking, 0·94, Bennington, 0·88, Ware (N.R.C.), 0·86, Knebworth and Fanhams Hall, 0·85, Moor Park and Nash Mills, 0·84, and Great Gaddesden, 0·78; and *considerable* at Tring, 0·74, Southgate, 0·70, and Berkhamsted and Cowroast, 0·67.

JULY.—I have already stated that July was remarkable for its extreme dryness. What little rain fell was gauged chiefly between 11th and 19th; 0·49 however was gauged at Fanhams Hall, Ware, on 7th. As the fall at the Ware (N.R.C.) station was only 0·10, and at Hadham only 0·09, this appears to have been the result of some very partial shower. The fall was almost identical with that of July, 1868, to judge by the mean fall at six of our oldest stations, namely, Rothamsted, Berkhamsted, Nash Mills, Bayfordbury, Hitchin, and Royston; in 1868 the mean fall at these stations was 0·33, in the present year it was 0·34 inch.

AUGUST.—Another dry month, the wet days falling chiefly into two groups, namely 4th to 7th, and 19th to 22nd; the 12th and 26th were however wet at all stations. On 5th the fall was *very considerable* at Royston, 0·83, but at no other station did it amount to half an inch, though at several it nearly approached that amount on 4th, 6th, 12th, and 26th.

SEPTEMBER.—With this month we enter upon a wet period which extended over the three autumn months. There were very few days without rain during the month. On 2nd the fall was *very considerable* at Cowroast, 0·97, Tring, 0·93, and Kensworth, 0·79; *considerable* at Berkhamsted, 0·68, Great Gaddesden, 0·57, and Nash Mills, 0·50. On 7th it was *considerable* at Odsey, 0·51 (**TS**), and Southgate, 0·50. On 10th, when the max. fell at all stations, the average being 1·41 inch, the fall was *very heavy* at Moor Park, 1·87; *heavy* at Datchworth, 1·70, Watford House, 1·68, Bayfordbury, 1·63, Knebworth, 1·60, Wansford House, 1·58, Gorhambury, 1·57, Hitchin, 1·56, and Tring and Kensworth, 1·50; *very great* at Nash Mills, 1·48, Rothamsted and Welwyn, 1·46, Cowroast, 1·37, Hitchin (High Down), 1·31, Southgate, 1·30, Fanhams Hall, 1·29, Great Gaddesden, 1·28, Bennington, 1·26, and Throcking, 1·25; *great* at Odsey, 1·24, Berkhamsted, 1·21, Therfield, 1·20, Ware (N.R.C.) and Royston, 1·12, and Hadham, 1·09. On 16th the fall was *considerable* at Southgate, 0·64, and on 28th at Kensworth, 0·56, and Cowroast, 0·55.

OCTOBER.—A cold wet month, the fall on several days being considerable, especially on 6th and 23rd. The only break in the spell of wet during the month was from 16th to 22nd. On 6th the fall was *very considerable* at Tring, 0·98, Berkhamsted and Hadham, 0·95, Great Gaddesden, 0·94, Hitchin (High Down), 0·93, Kensworth, 0·91, Rothamsted and Welwyn, 0·88, and Nash Mills, 0·80; *considerable* at Wansford House, 0·70, Odsey, 0·64, Watford House, 0·59, and Southgate, 0·58. On 14th it was *con-*

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siderable at Odsey, 0·67, Therfield, 0·66, Fanhams Hall, 0·59, Hitchin (High Down), 0·51, and Ware (N.R.C.), 0·50. On 23rd, when max. at most stations occurred, it was *very great* at Tring, 1·31, and Cowroast, 1·26; *great* at Knebworth, 1·07, Hadham, 1·06, Berkhamsted and Fanhams Hall, 1·05, Bayfordbury, 1·03, Welwyn, 1·01, and Southgate and Throcking, 1·00; *very considerable* at Bennington and High Down, 0·97, Ware (N.R.C.), 0·96, Datchworth, 0·94, Gorhambury and Great Gaddesden, 0·93, Royston, 0·91, Nash Mills and Therfield, 0·90, Hitchin, 0·87, Odsey, 0·84, Wansford House and Watford House, 0·80, and Moor Park, 0·75; and *considerable* at Rothamsted, 0·74. On 24th the fall was *great* at Kensworth, 1·05. On 30th it was *considerable* at Tring, 0·61, Cowroast, 0·60, Berkhamsted, 0·55, and Nash Mills, 0·50.

NOVEMBER.—A wet month, with a short break of dry weather between 15th and 20th. On 3rd the fall was *considerable* at Therfield, 0·54, Knebworth, 0·52, and Royston, 0·51. On 24th the fall was *very considerable* at Southgate, 0·80; on 25th it was *considerable* at Welwyn, 0·57, and Fanhams Hall, 0·50. On 26th it was *very considerable* at Southgate, 0·78; and *considerable* at Tring and Nash Mills, 0·64, Berkhamsted, 0·59, Moor Park and Cowroast, 0·56, Gorhambury, 0·55, Bayfordbury, 0·54, Wansford House, 0·52, Rothamsted and Kensworth, 0·51, and Ware (N.R.C.), 0·50. On 27th it was *considerable* at Wansford House and Cowroast, 0·50, and on 29th at Tring, 0·53.

DECEMBER.—This was one of the driest months in the year, and very cold; snow fell on 5th, 6th, 9th, and 29th, but at no station was the rainfall on any one day considerable except at Hitchin (High Down) on 25th, when 0·61 was gauged.

From the above it appears that the daily fall has been *very heavy* on one occasion, *very great* on two occasions, *great* on two, *very considerable* on ten, and *considerable* on eighteen; also that it has exceeded half an inch at some one or more stations on thirty-three different occasions, of which two were in January, two in February, two in March, three in April, four in May, three in June, one in August, five in September, five in October, and six in November; July and December being the only two months in which the max. fall was less than half inch.

During the year there were 90 days absolutely without any rain at any of the 19 stations from which I have received a daily record, of which 7 were in January, 5 in February, 15 in March, 9 in April, 5 in May, 12 in June, 17 in July, 12 in August, 2 in September, 3 in October, 2 in November, and 1 in December. The longest period of dry weather was from July 21st to Aug. 3rd, or 14 days, during which rain was gauged at only one station, namely 0·1 at Ware (N.R.C.), on 21st and 27th.

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IX.

METEOROLOGICAL OBSERVATIONS TAKEN AT WANSFORD HOUSE, WATFORD, DURING THE YEAR 1885.

By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 11th May, 1886.

Longitude of Station, 0° 23′ 40″ W.; Latitude, 51° 39′ 45″ N. Ground-level at thermometer-stand and rain-gauge 223 feet, and cistern of barometer 234 feet above Ordnance Datum. Barometer, a Fortin. Thermometers, dry-bulb, wet-bulb, Negretti maximum, and Rutherford minimum, 4 feet above the ground in a Stevenson screen, over grass. Rain-gauge, Snowdon pattern, 5 inches in diameter, rim 1 foot above the ground. For further particulars the report for the year 1883 * may be referred to.

The monthly means and other results of the daily observations in 1885 are given in the accompanying tables (pp. 84, 85); and from these tables the following summary for the seasons (winter including Dec. 1884 from the previous report) is deduced, results for Greenwich Observatory being added for comparison as usual.

Means for the Seasons from Dec. 1884 to Nov. 1885, at Watford.

Seasons, 1884–85.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	29·827	39·2	9·4	·213	90	9·44	57	7·7
Spring	29·902	45·6	16·6	·231	75	7·49	41	6·0
Summer.....	30·070	60·3	19·3	·380	71	3·34	28	5·8
Autumn.....	29·846	47·6	12·8	·291	87	11·93	61	6·9

The same at Greenwich.

Seasons, 1884–85.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	29·827	40·5	9·1	·220	87	6·30	52	7·8
Spring	29·891	46·0	18·1	·238	77	5·65	36	6·3
Summer.....	30·055	60·6	22·1	·381	73	3·49	22	5·9
Autumn.....	29·830	48·2	13·4	·301	86	9·98	61	7·4

* 'Trans. Herts Nat. Hist. Soc.,' Vol. III, Part 5, p. 181.

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Results of Meteorological Observations taken at Wansford House, Watford, in 1885.

Months.	Pressure of the Atmosphere.	Temperature of the Air.									Humidity of the Air.		
		9 a.m.	Means of		Adopted Mean.	Mean Daily Range.	Absolute Min. and Max.				Absolute Range.	Dryness.	Tension of Vapour.	Relative Humidity.
			Min.	Max.			Min.	Date.	Max.	Date.				
	ins.	°	°	°	°	°	°	°	°	°	°	°	in.	%
January	29·910	35·0	31·4	39·8	35·4	8·4	22·1	22nd	53·0	29th	30·9	2·3	·186	91
February	29·702	41·7	37·2	48·4	42·4	11·2	24·1	21st	57·1	24th	33·0	2·6	·238	90
March	30·092	38·8	32·7	48·2	39·9	15·5	23·9	8th	59·3	20th	35·4	5·3	·192	81
April	29·805	47·7	38·3	56·2	47·4	17·9	25·9	5th	71·9	20th	46·0	8·4	·240	73
May	29·809	50·3	40·8	57·2	49·4	16·4	30·7	8th	70·1	28th	39·4	8·8	·262	72
June	30·047	60·3	48·8	68·8	59·3	20·0	37·9	11th	84·3	4th	46·4	9·4	·373	71
July	30·188	63·7	52·4	73·7	63·3	21·3	43·2	2nd	87·5	25th	44·3	10·4	·407	69
August	29·975	59·0	49·7	66·3	58·3	16·6	38·5	14th	77·5	16th	39·0	9·1	·360	72
September	29·900	55·6	46·5	63·0	55·0	16·5	30·8	27th	76·7	15th	45·9	5·4	·364	82
October	29·727	45·0	39·6	51·6	45·4	12·0	30·4	30th	59·6	2nd	29·2	4·0	·257	86
November	29·910	42·4	37·4	47·4	42·4	10·0	27·6	13th	57·3	29th	29·7	1·9	·252	93
December	30·213	36·8	32·2	42·7	37·2	10·5	22·3	11th	49·7	3rd	27·4	2·4	·199	91
Year	29·940	48·0	40·6	55·3	48·0	14·7	22·1	Jan. 22	87·5	July 25	65·4	5·9	·278	81

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RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT WANSFORD HOUSE, WATFORD, IN 1885 *(continued)*.

MONTHS.	RAINFALL.					CLOUD.			WIND.									
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount, 0-10.	No. of days of		Mean Force, 0-12.	Number of days of								
	Ins.	Ins.	Date.	Rain or Snow.	Snow only.		Clear Sky.	Over-cast.		N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm.
January	3·05	·88	31st	17	3	8·6	3	22	1·6	1	5	3	7	4	5	2	3	1
February	3·02	·52	16th	21	1	7·1	6	15	1·4	1	2	0	5	7	8	2	2	1
March	1·80	·70	21st	7	2	5·3	7	9	1·7	5	10	2	2	2	5	2	3	0
April	2·65	·72	15th	14	0	6·1	6	9	2·2	4	8	3	4	6	3	1	1	0
May	3·04	·73	21st	20	1	6·5	2	6	2·0	7	2	1	4	2	3	4	8	0
June	1·92	·52	7th	10	0	4·6	10	10	1·7	4	6	2	5	2	6	2	1	2
July	0·32	·12	11th	6	0	5·2	8	9	1·4	2	5	4	4	1	4	1	3	7
August	1·10	·27	26th	12	0	7·7	3	12	1·7	3	7	3	2	1	5	1	3	6
September	4·10	1·58	10th	20	0	6·8	2	11	1·7	3	2	0	2	2	8	5	4	4
October	4·14	·80	23rd	19	1	6·5	5	15	1·9	2	3	3	2	2	3	8	7	1
November	3·69	·52	26th	22	0	7·5	5	18	1·5	2	6	7	2	2	5	3	3	0
December	1·19	·32	30th	15	4	7·0	7	16	1·3	4	2	0	1	4	5	8	4	3
Year	30·02	1·58	Sep. 10	183	12	6·6	64	152	1·7	36	58	28	40	37	62	39	40	25

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Results of Meteorological Observations taken at Wansford House, Watford, in 1885.

Months.	Pressure of the Atmosphere.	Temperature of the Air.										Humidity of the Air.		
		9 a.m.	Means of		Adopted Mean.	Mean Daily Range.	Absolute Min. and Max.				Absolute Range.	Dryness.	Tension of Vapour.	Relative Humidity.
			Min.	Max.			Min.	Date.	Max.	Date.				
	ins.	°	°	°	°	°	°	°	°	°	°	°	in.	%
January	29·910	35·0	31·4	39·8	35·4	8·4	22·1	22nd	53·0	29th	30·9	2·3	·186	91
February	29·702	41·7	37·2	48·4	42·4	11·2	24·1	21st	57·1	24th	33·0	2·6	·238	90
March	30·092	38·8	32·7	48·2	39·9	15·5	23·9	8th	59·3	20th	35·4	5·3	·192	81
April	29·805	47·7	38·3	56·2	47·4	17·9	25·9	5th	71·9	20th	46·0	8·4	·240	73
May	29·809	50·3	40·8	57·2	49·4	16·4	30·7	8th	70·1	28th	39·4	8·8	·262	72
June	30·047	60·3	48·8	68·8	59·3	20·0	37·9	11th	84·3	4th	46·4	9·4	·373	71
July	30·188	63·7	52·4	73·7	63·3	21·3	43·2	2nd	87·5	25th	44·3	10·4	·407	69
August	29·975	59·0	49·7	66·3	58·3	16·6	38·5	14th	77·5	16th	39·0	9·1	·360	72
September	29·900	55·6	46·5	63·0	55·0	16·5	30·8	27th	76·7	15th	45·9	5·4	·364	82
October	29·727	45·0	39·6	51·6	45·4	12·0	30·4	30th	59·6	2nd	29·2	4·0	·257	86
November	29·910	42·4	37·4	47·4	42·4	10·0	27·6	13th	57·3	29th	29·7	1·9	·252	93
December	30·213	36·8	32·2	42·7	37·2	10·5	22·3	11th	49·7	3rd	27·4	2·4	·199	91
Year	29·940	48·0	40·6	55·3	48·0	14·7	22·1	Jan. 22	87·5	July 25	65·4	5·9	·278	81

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RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT WANSFORD HOUSE, WATFORD, IN 1885 *(continued)*.

MONTHS.	RAINFALL.					CLOUD.			WIND.									
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount, 0-10.	No. of days of		Mean Force, 0-12.	Number of days of								
	Ins.	Ins.	Date.	Rain or Snow.	Snow only.		Clear Sky.	Over-cast.		N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm.
January	3·05	·88	31st	17	3	8·6	3	22	1·6	1	5	3	7	4	5	2	3	1
February	3·02	·52	16th	21	1	7·1	6	15	1·4	1	2	0	5	7	8	2	2	1
March	1·80	·70	21st	7	2	5·3	7	9	1·7	5	10	2	2	2	5	2	3	0
April	2·65	·72	15th	14	0	6·1	6	9	2·2	4	8	3	4	6	3	1	1	0
May	3·04	·73	21st	20	1	6·5	2	6	2·0	7	2	1	4	2	3	4	8	0
June	1·92	·52	7th	10	0	4·6	10	10	1·7	4	6	2	5	2	6	2	1	2
July	0·32	·12	11th	6	0	5·2	8	9	1·4	2	5	4	4	1	4	1	3	7
August	1·10	·27	26th	12	0	7·7	3	12	1·7	3	7	3	2	1	5	1	3	6
September	4·10	1·58	10th	20	0	6·8	2	11	1·7	3	2	0	2	2	8	5	4	4
October	4·14	·80	23rd	19	1	6·5	5	15	1·9	2	3	3	2	2	3	8	7	1
November	3·69	·52	26th	22	0	7·5	5	18	1·5	2	6	7	2	2	5	3	3	0
December	1·19	·32	30th	15	4	7·0	7	16	1·3	4	2	0	1	4	5	8	4	3
Year	30·02	1·58	Sep. 10	183	12	6·6	64	152	1·7	36	58	28	40	37	62	39	40	25

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In the report for the year 1883, already alluded to, the means of some of the principal results of observations taken during the five years 1878-82 are given. In the following table the period of observation is extended to include the year 1885, thus giving the means for eight years, and this is followed by a table giving the difference in 1885 from the means of these eight years.

MEANS OF OBSERVATIONS TAKEN AT WANSFORD HOUSE, WATFORD, 1878-85.

Months.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
January	30·098	36·1	9·3	·190	89	2·16	14	7·6
February	29·934	40·2	10·8	·219	89	2·89	18	7·6
March	30·015	41·5	15·2	·210	82	1·51	12	6·1
April	29·990	46·1	16·6	·242	77	2·40	14	6·2
May	29·977	52·5	18·4	·292	71	2·15	14	6·2
June	29·958	58·4	17·3	·371	74	3·24	16	6·6
July	29·923	61·4	17·2	·410	74	2·54	15	6·6
August	29·925	61·1	16·0	·418	77	2·70	12	7·0
September	29·951	56·8	16·1	·385	83	2·91	14	6·4
October	29·933	47·7	13·1	·288	87	3·13	17	6·6
November	29·940	41·7	11·7	·233	88	2·91	19	6·5
December	29·987	37·2	10·0	·199	90	2·45	16	7·3
Year	29·969	48·4	14·3	·288	82	30·99	181	6·7

DIFFERENCE IN 1885 FROM MEANS OF 1878-85, AT WATFORD.

Months.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	in.	°	°	in.	%	ins.		
January	—·188	—0·7	—0·9	—·004	+2	+0·89	+ 3	+1·0
February	—·232	+2·2	+0·4	+·019	+1	+0·13	+ 3	—0·5
March	+·077	—1·6	+0·3	—·018	—1	+0·29	— 5	—0·8
April	—·185	+1·3	+1·3	—·002	—4	+0·25	=	—0·1
May	—·168	—3·1	—2·0	—·032	+1	+0·89	+ 6	+0·3
June	+·089	+0·9	+2·7	+·002	—3	—1·32	— 6	—2·0
July	+·265	+1·9	+4·1	—·003	—5	—2·22	— 9	—1·4
August	+·050	—2·8	+0·6	—·050	—5	—1·60	=	+0·7
September	—·051	—1·8	+0·4	—·025	—1	+1·19	+ 6	+0·4
October	—·206	—2·3	—1·1	—·031	—1	+1·01	+ 2	—0·1
November	—·030	+0·7	—1·7	+·019	+5	+0·78	+ 3	+1·0
December	+·226	=	+0·5	=	+1	—1·26	— 1	—0·3
Year	—·029	—0·4	+0·4	—·010	—1	—0·97	+ 2	—0·1

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From these tables (substituting, however, for the values for Dec. 1885, those for Dec. 1877) the following summaries of the means for the seasons from Dec. 1877 to Nov. 1885, and of the differences in the seasons of 1884-85 from these means, are compiled.

MEANS FOR THE SEASONS FROM DEC. 1877, to NOV. 1885, AT WATFORD.

Seasons, 1877-85.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0-10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	30·000	37·9	10·1	·204	89	7·50	49	7·5
Spring	29·952	46·8	16·7	·248	76	6·06	39	6·2
Summer.....	29·942	60·3	16·8	·400	75	8·35	45	6·8
Autumn.....	29·941	48·6	13·7	·302	86	8·95	48	6·7

DIFFERENCE IN 1884-85 FROM MEANS OF 1877-85, AT WATFORD.

Seasons, 1884-85.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0-10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	—·173	+1·3	—0·7	+·009	+ 1	+1·94	+ 8	+0·2
Spring	—·050	—1·2	—0·1	—·017	— 1	+1·43	+ 2	—0·2
Summer.....	+·128	=	+2·5	—·020	— 4	—5·01	—17	—1·0
Autumn.....	—·095	—1·0	—0·9	—·011	+ 1	+2·98	+13	+0·2

The weather of the year 1885, taken as a whole, presents no strongly-marked feature, in this respect being like that of 1883. The mean pressure of the atmosphere was a little below the average; the lowest pressures recorded were 28·957 ins. on January 11th, and 28·995 ins. on October 10th, and the highest, 30·609 ins. on March 14th, and 30·611 ins. on December 23rd, giving a range of 1·654 in. The temperature was a little below the average, and there were no excessively high nor excessively low readings, though the mean daily range was above the average. The rainfall, although less than the average of the eight years of our observations, was still considerably above the average of a long period, and the number of rainy days was also great. There was a greater preponderance of N.E. winds, and a less preponderance of S.W. than usual.

Compared with the previous year, in 1885 the mean temperature was 2°·2 lower, the mean daily range 0°·5 less, the relative humidity 1 per cent. greater, and the rainfall 7·67 ins. greater. Rain (or snow) fell on 31 days more in 1885 than in 1884, and

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snow (only) on 2 days more. The sky, although rather more frequently completely overcast, was much more often clear of cloud. The estimated force of the wind was rather less than in 1884. The chief difference in the weather of the two years will thus be seen to consist in the much greater rainfall and number of wet days in 1885 than in 1884, one being a rather wet and the other a very dry year.

In the winter of 1884-85 (Dec. to Feb.) the mean pressure of the atmosphere was below the average, the mean temperature was rather high, the relative humidity was about the average, and the rainfall and number of days of rain were considerably above it. In the spring (March to May) the mean pressure was about the average, the mean temperature rather low, the relative humidity about the average, and the rainfall and number of days of rain were again above it. In the summer (June to Aug.) the mean pressure was high, the mean temperature the average, the mean daily range of temperature being considerable (owing to hot days in June and hotter still in July), the relative humidity was very low (due to the dryness of the air in July), and the rainfall and number of days of rain were excessively small (owing chiefly to the drought of July). In the autumn (Sept. to Oct.) the mean pressure and mean temperature were rather low, the relative humidity was the average, and the rainfall and number of days of rain were considerable.

The following notes record the general character of the weather in each month, and its principal changes.

JANUARY.—Of average temperature, very dull, with a humid atmosphere of rather low pressure, and with a considerable amount of rain, but very little snow. The month may be divided into two dry and two wet periods. From 1st to 7th only 0·02 in. of rain fell (on 5th), from 8th to 16th rain or snow fell every day, from 17th to 24th no rain fell, and from 25th to 31st rain fell every day. For the last 5 days the weather was much warmer than during the earlier part of the month.

		°		°		°		°
27th to 31st.....	9 a.m.	46·1	Mean Min.	41·6	Mean Max.	50·5	Mean	46·1
Mean of Month	,,	35·0	,,	31·4	,,	39·8	,,	35·4
Difference	,,	11·1	,,	10·2	,,	10·7		10·7

Min. below 32° on 20 days (above 40° on 3; 28th to 30th); max. above 42° on 12, above 52° on 1 (29th). On 11th barometric pressure was the lowest in the year. There was a gradual fall from 30·318 ins. at 9 a.m. on 7th to 29·038 ins. at 11 p.m. on 10th and 28·957 ins. at 9 a.m. on 11th, and then a gradual rise to 30·259 ins. at 9 a.m. on 19th, this depression covering the first wet period. There was again a gradual fall from 30·131 ins. at 9 a.m. on 24th to 29·124 ins. at 9 a.m. on 31st, coincident with the second wet period. On the last three days more than an inch and a half of rain fell, with hail on 31st. Southerly winds (S.E. to S.W.) prevailed.

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FEBRUARY.—Very mild, rather dull (though brighter than the average of our eight-year period), with a humid atmosphere of very low pressure, and with a considerable amount of rain falling on a great number of days, but scarcely any snow (only a slight fall on 17th). The wet period which began on 25th January lasted until 8th February, rain falling on 15 consecutive days. Rain also fell consecutively from 14th to 17th, and from 21st to 28th. The warm weather of the end of January continued for the first 3 days only of February. On 4th it became decidedly colder, on 11th warmer, on 17th again colder, and on 23rd again warmer.

		°		°		°		°
1st to 3rd	9 a.m.	44·4	Mean Min.	40·7	Mean Max.	49·0	Mean	44·7
4th to 10th.....	,,	38·6	,,	33·8	,,	47·4	,,	39·9
11th to 16th	,,	47·5	,,	42·4	,,	51·4	,,	47·1
17th to 22nd	,,	34·6	,,	29·7	,,	42·5	,,	35·6
23rd to 28th	,,	45·3	,,	41·2	,,	52·0	,,	46·2

These figures give a rather singular result, and afford a good illustration of the fickleness of our climate. Of the five periods into which the month of February is here divided, the first has a mean temperature between that of March and April, the second has a February mean temperature, the third an April, the fourth a January, and the fifth an April temperature again. The change from the third period (of 6 days) to the fourth period (also of 6 days) is from a mean temperature higher than that of the spring to one lower than that of the winter of our eight-year period. Min. below 32° on 7 days; max. above 42° on 26 (every day but 20th and 21st), above 52° on 5. Southerly winds prevailed to a greater extent even than in January.

MARCH.—Cold, bright, with an atmosphere of average pressure and humidity, and with a small amount of rain (though more than our eight-year mean) on very few days, but with a considerable fall of snow. Of the total rainfall (including snow), 0·66 in. fell on 3rd, and 0·70 in. (as snow) on 21st, leaving only 0·44 in. for the rest of the month, this amount being distributed over 5 days. From 9th to 20th, inclusive, only 0·02 in. fell (on 17th), and from 23rd to 31st, 0·16 in. (on 26th). There was no decided change in temperature. The mean was considerably below that of February, though the mean maximum was about the same in both months. Min. below 32° on 14 days; max. above 52° on 7. The range in barometric pressure was considerable, from 29·295 ins. at 9 a.m. on 6th to 30·609 ins. at 9 a.m. on 14th, a range of 1·314 in. The prevailing direction of the wind was N. to N.E.

APRIL.—Warm, of average brightness, with a rather dry atmosphere of rather low pressure, and with a considerable amount of rain. The first half of the month was much colder than the second half.

		°		°		°		°
1st to 15th.....	9 a.m.	41·7	Mean Min.	35·1	Mean Max.	50·5	Mean	42·4
16th to 30th	,,	53·5	,,	41·4	,,	63·2	,,	52·7
Difference	,,	11·8	,,	6·3	,,	12·7	,,	10·3

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The change, however, did not take place until the 16th, and the temperature rose each day for the next four days, the mean being on 16th 44°·3, 17th 49°·1, 18th 51°·4, 19th 55°·4, and 20th 56°·9. During this period the maximum rose more than 20°, but the minimum varied very little, giving a range on 16th of 11°·6 and on 20th of 33°·8. Min. below 42° on 25 days, below 32° on 3; max. above 52° on 16, above 62° on 8. Northerly winds chiefly prevailed during the colder period and southerly during the warmer period. Thunder was heard and hail fell on several days.

MAY.—Very cold, rather dull, with a rather dry atmosphere of rather low pressure, and with a considerable amount of rain falling on a great number of days. Snow fell on 8th after an interval of 46 days without. Rain fell every day to 8th, except on 3rd; and again, after an interval of five days without, every day from 14th to 25th, except on 24th. The last 6 days were warmer than the rest of the month, having a mean of 57°·2, being 7°·8 above the mean of the month. Min. below 42° on 18 days, below 32° on 1 (8th, when snow fell); max. above 62° on 6 (26th to 31st). It is unusual to have frost and snow so late in the year as the 8th of May. The prevailing direction of the wind was from W. through N.W. to N. On the day of maximum rain, 21st, with a fall of 0·73 in., there was a thunderstorm at about 3 p.m. with heavy hail. Thunder was heard and hail fell on several other days.

JUNE.—Rather warm, very bright, with a dry atmosphere of average pressure, and with a small amount of rain. The rainfall was very unequally distributed, the five days from 5th to 9th having an inch and a half, leaving only 0·42 in. for the rest of the month. No rain fell from 10th to 15th nor from 25th to July 7th. The range of temperature was very great, the mean daily range being 20°·0, and there having been six days with a range exceeding 30° (2nd, 3rd, 4th, 12th, 14th, and 18th). There were two very low minima (for June), on 11th, 37°·9, and 18th, 39°·7. On the former date a ground frost occurred. Min. temp. below 52° on 21 days, below 42° on 2 (2nd and 11th); max. above 62° on 28, above 72° on 9, above 82° on 1 (4th). N.E. and S.W. winds prevailed, but not to any great extent.

JULY.—Warm, bright, with a very dry atmosphere of considerable pressure, and with an exceedingly small fall of rain on a very small number of days. The total amount of rain recorded for the month (less than one-third of an inch) is all that fell from the 25th of June to the 3rd of August, inclusive, a period of 40 days; from the 17th of June to the 5th of August, 50 days, only 0·60 in. fell; and from the 9th of June to the 1st of September, 85 days, only 1·85 in., considerably less than half the fall of September. Three days (25th to 27th) were very hot and dry.

		°		°		°		°		°
25th.....9	a.m.	69·9	Wet bulb	61·8	Min.	49·1	Max.	87·5	Mean	68·8
26th.....	,,	76·0	,,	65·7	,,	55·7	,,	86·5	,,	72·7
27th.....	,,	75·6	,,	67·8	,,	57·6	,,	84·8	,,	72·7

giving a mean for the period of 71°·4. The great range of tem-

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perature on the 25th (38°·4), and the extreme dryness of the air on the 26th (19°·3), the dew-point being 57°·7, and giving a relative humidity of 51 per cent., are noticeable features of the month. The mean daily range of temperature (21°·3) was even greater than in June, and, as in that month, there were six days with a range exceeding 30° (10th, 11th, 23rd, 24th, 25th, 26th), one of which (25th) had a range of 38°·4. Min. below 52° on 13 days; max. above 72° on 15, above 82° on 3 (25th to 27th). There was no great prevalence of wind from any one quarter. No thunderstorms are recorded.

August.—Rather cold, dull, with a rather dry atmosphere of average pressure, and a very small amount of rain. The rain was distributed pretty evenly over the month, but none fell from 13th to 19th, 7 days. There was no decided change in temperature, but the latter part of the month was rather colder than the earlier. Both the mean daily range and the absolute range were much less than in either of the other two summer months, and in place of the six days with a range exceeding 30° in each of these months, there was only one (15th). Min. below 52° on 20 days, below 42° on 2 (14th and 15th); max. above 62° on 24, above 72° on 5. N.E. winds mostly prevailed, and the next in frequency were S.W. There was a thunderstorm on the evening of the 7th, and thunder was heard on 5th and 6th.

September.—Cold, rather dull, with an atmosphere of average pressure and humidity, and with a very heavy rainfall on a large number of days. Considerably more rain fell in September than during the three previous months together, and more in one day (10th) than during July and August together. Rain fell every day but two (1st and 3rd) to 12th, to the extent of 2·80 ins., and again every day from 15th to 20th. Although the range of temperature exceeded 30° on only one day (22nd), the absolute range was great, owing to the early frost of the 27th (30°·8) and the unusually high temperature of the 15th (76°·7). Min. below 52° on 24 days, below 42° on 6, below 32° on 1 (27th), the first frost of the winter; max. above 62° on 18, above 72° on 1 (15th). As is usual in wet weather, S.W. winds greatly prevailed.

October.—Very cold, of average brightness, with an atmosphere of low pressure and average humidity, and with a very heavy rainfall on a large number of days. This was the wettest month in the year, the fall of rain slightly exceeding that of September. The max. fall of the 23rd (0·80 in.) was nearly equalled on the 6th, when 0·70 in. fell; 0·45 in. fell on 30th, and about a quarter of an inch on each of the following days:—8th, 9th, 14th, 15th, 25th, and 31st. The first fall of snow of the winter occurred on the 30th, and the second frost on the same day, the min. not having been below 32° since Sept. 27th. Min. below 42° on 22 days, below 32° on 1 (30th); max. above 52° on 13. The low pressure of 28·995 ins. occurred at 9 a.m. on the 10th. W. and N.W. winds greatly prevailed. The small number of days of S.W. winds is a remarkable feature for such a wet month.

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NOVEMBER.—Rather cold, dull, with a very humid atmosphere of rather low pressure, and with a large amount of rain falling on a great number of days, the third very wet month in succession. Rain fell every day but two (7th and 13th) from 2nd to 14th, and again every day but one (20th) from 19th to 30th, none falling from 15th to 18th. From 23rd to 30th 2·80 ins. fell, an average of 0·35 in. per day for the 8 days, with a min. of 0·15 in. on 29th and a max. of 0·52 in. on 26th. The temperature varied considerably; after some rather warm weather up to the 14th, it became much colder for a few days, with minima below 30° from 16th to 19th; after 25th it again became warmer. Min. below 32° on 6 days; max. above 52° on 5. N.E. and E. winds prevailed. There was a considerable amount of fog.

DECEMBER.—Cold, rather dull, with a humid atmosphere of considerable pressure, and a small amount of rain. The temperature of this month was almost as erratic as that of February. There was a decided change to colder weather on 8th, on 13th it became warmer, and on 23rd again colder.

		°		°		°		°
1st to 7th	9 a.m.	39·7	Mean Min.	35·1	Mean Max.	45·0	Mean	39·9
8th to 12th.....	,,	27·6	,,	24·4	,,	35·2	,,	29·1
13th to 22nd	,,	41·0	,,	36·5	,,	45·3	,,	40·9
23rd to 31st	,,	35·2	,,	29·6	,,	42·1	,,	35·6

Of these four periods the first and third have a mean temperature of about that of February and November, the second much below that of any month in the year, and the fourth that of January. The second period (of 5 days) differs more from the first (of 7) and the third (of 10) than winter usually does from spring. Min. temp. below 32° on 15 days; max. above 42° on 17. The highest barometric pressure of the year, 30·611 ins., occurred on the 23rd; but as the pressure on March 14th was 30·609 ins., there may be considered to have been two practically equal maxima. Westerly winds greatly prevailed. There was a considerable amount of fog, which was very dense on Christmas Day. The month and year closed stormily, there being storms of hail with strong wind on 28th and 29th, and a rather heavy snowstorm on 30th.

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Dates of Flowering of Plants observed in 1885, with the Mean Date for 1876–85.

No.	Species.	Watford 1.	Watford 2.	Croxley.	Harpenden.	Hertford.	Ware.	High Wych.	Hitchin.	Odsey.	Mean.
1.	*Anemone nemorosa*	Mar. 31	Apl. 3	.....	Mar. 20	.....	Apl. 3	.....	Mar. 28	.....	Mar. 12
2.	*Ficaria verna*	Mar. 17	Mar. 2	Mar. 24	Mar. 13	.....	Apl. 1	.....	Mar. 21	.....	Feb. 18
3.	*Ranunculus acris*	.....	June 1	.....	Apl. 28	.....	.....	.....	May 27	.....	Apl. 22
4.	*Caltha palustris*	Apl. 20	Apl. 3	Apl. 13	Apl. 21	.....	Apl. 17	.....	Mar. 28	.....	Mar. 21
5.	*Papaver Rhœas*	June 4	June 1	.....	May 29	.....	June 9	.....	June 7	.....	May 28
6.	*Nasturtium officinale*	.....	June 20	.....	.....	May 31	.....	.....	.....	.....	June 2
7.	*Cardamine pratensis*	Apl. 26	.....	Apl. 13	Apl. 24	Apl. 27	Apl. 22	.....	.....	.....	Apl. 12
8.	*Alliaria officinalis*	Apl. 24	.....	Apl. 21	Apl. 28	.....	.....	.....	Apl. 29	.....	Apl. 13
9.	*Draba verna*	Mar. 22	.....	Mar. 20	Mar. 25	.....	.....	.....	Mar. 30	.....	Mar. 6
10.	*Viola odorata*	.....	Mar. 1	.....	.....	.....	.....	Feb. 14	Mar. 4	Mar. 11	Feb. 10
11.	*Polygala vulgaris*	June 14	June 8	.....	June 18	May 26	May 31	.....	May 31	.....	May 7
12.	*Lychnis Flos-cuculi*	.....	June 1	.....	May 30	May 20	.....	.....	June 2	.....	May 24
13.	*Stellaria Holostea*	Apl. 20	.....	Apl. 24	Apl. 21	Apl. 22	Apl. 22	Apl. 19	Apl. 23	.....	Apl. 4
14.	*Malva silvestris*	June 14	June 11	.....	June 14	June 8	June 12	.....	June 18	.....	June 6
15.	*Hypericum quadratum*	.....	July 8	.....	July 11	July 1	.....	.....	July 21	.....	July 2
16.	*H. pulchrum*	.....	.....	.....	June 24	July 1	.....	.....	June 29	.....	June 27
17.	*Geranium Robertianum*	Apl. 30	May 6	.....	May 2	May 1	.....	May 10	May 22	.....	Apl. 25
18.	*Euonymus europæus*	June 9	June 9	.....	June 3	.....	.....	.....	.....	.....	May 29
19.	*Acer Pseudo-platanus*	May 14	June 1	.....	May 10	.....	.....	.....	.....	.....	Apl. 25
20.	*Æsculus Hippocastanum*	May 14	.....	.....	May 15	May 12	.....	.....	.....	.....	May 4
21.	*Cytisus Laburnum*	May 14	.....	.....	May 23	May 10	.....	.....	.....	.....	May 19
77.	*Narcissus Pseudo-Narcissus*	Mar. 19	.....	Mar. 26	Mar. 10	Mar. 12	Mar. 12	Mar. 22	.....	Jan. 31	Jan. 22
78.	*Galanthus nivalis*	Jan. 31	.....	.....	Feb. 9	Jan. 29	Feb. 10	Feb. 3	Apl. 25	.....	Apl. 13
79.	*Scilla nutans*	Apl. 19	.....	.....	Apl. 18	Apl. 27	Apl. 21	.....			

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X.

REPORT ON PHENOLOGICAL PHENOMENA OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1885.

By JOHN HOPKINSON, F.L.S., F.G.S., etc.

Read at Watford, 11th May, 1886.

WITH one exception all our observers of Phenological Phenomena in 1883 and 1884 have continued to observe in 1885. We have no longer returns for Royston from Mr. A. Kingston, and having no other observer there this station disappears from our table. Croxley, near Rickmansworth, where observations have been taken by Mr. Lloyd, is added, and there is also a second column for Watford, where we have an additional observer in Mrs. Applebee.

The phenological stations, the returns from which are entered in the accompanying table giving the earliest dates of flowering of the plants in the Royal Meteorological Society's list, are as follows:—

Station.	N. Lat.	Long.	Observer.
Watford (1)	51 39	0 24w	Mrs. J. Hopkinson.
,, (2)	51 39	0 24w	Mrs. Applebee.
Croxley, Rickmansworth	51 39	0 27w	Mr. F. G. Lloyd.
Harpenden	51 48½	0 21w	Mr. J. J. Willis.
Hertford	51 48	0 5w	Mr. R. T. Andrews.
Ware (Fanhams Hall)	51 49	0 1w	Major R. B. Croft.
High Wych, Sawbridgeworth	51 48½	0 8 E	Miss Simpson.
Hitchin	51 57	0 16w	Natural Hist. Club.
Odsey	52 1½	0 7w	Mr. H. G. Fordham.

Details of the observations of insects and birds are given as before in Mr. Silvester's Report on the Insects (p. 49) and Mr. Littleboy's Notes on the Birds (p. 53), and therefore the earliest observations are, as usual, alone given on the following page. The only additional observation is that of frog-spawn, which was first observed at Watford on the 28th of February; at Fanhams Hall, Ware, on the 7th of March; at Hertford on the 14th; and at Harpenden on the 28th.

The general result of the observations of the time of flowering of plants, as recorded in the accompanying table, is that 1885 may be considered a late year. The mean of the whole of the 79 species, every one of which was observed in 1885, gives 3·6 days late. Of the 60 selected species which have now been observed for at least 8 years, and most of them for 10 years, the mean is 4·2 days late. Of these 60 species 45 came into flower later than the mean of 1876-85, 12 earlier, and 3 on the same day as the mean.

Of the 30 species which come into flower by the middle of May, which we consider as spring flowers, 27 appeared after the mean date, 2 before it, and 1 on the same day as the mean; and of the 30 which come into flower after this time, which we consider as summer flowers, 18 appeared after the mean date, 10 before it, and 2 on the same day as the mean. The spring flowers were on the average a week late and the summer flowers a day and a half late.

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Earliest Dates of Observations of Insects, Birds, etc., in 1885, with the Mean Date for 1876-85.

No.	Phenomena.	1885.	Mean.
	Insects.		
80.	*Melolontha vulgaris* (cock-chafer) appears	June 1	May 26
81.	*Rhizotrogus solstitialis* (fern-chafer) ap.	June 23	June 12
82.	*Timarcha lævigata* (bloody-nosed beetle) ap.	May 22	June 7
83.	*Lampyris noctiluca* (glow-worm) ap.	July 3	May 29
84.	*Apis mellifica* (honey-bee) ap.	Feb. 5	Jan. 25
85.	*Vespa vulgaris* (common wasp) ap.	Apl. 20	Mar. 28
86.	*Pieris Brassicæ* (large white butterfly) ap.	Mar. 29	Apl. 8
87.	*P. Rapæ* (small white butterfly) ap.	Apl. 10	Mar. 26
88.	*Anthocaris cardamines* (orange-tip butterfly) ap.	May 2	May 8
89.	*Epinephele Janira* (meadow-brown butterfly) ap.	June 7	May 27
90.	*Bibio Marci* (St. Mark's fly) ap.	Apl. 27	Apl. 27
	Birds.		
91.	*Strix Aluco* (brown-owl) hoots	.....	Mar. 18
92.	*Muscicapa grisola* (flycatcher) arrives	Apl. 19	May 12
	——— nests	.....	May 30
	——— hatches	.....	June 30
	——— departs (last seen)	.....	Aug. 30
93.	*Turdus musicus* (song-thrush) sings	Jan. 20	Jan. 12
	——— nests	Mar. 20	Mar. 18
	——— hatches	Apl. 25	Apl. 7
94.	*T. Pilaris* (field-fare) arrives	Oct. 4	Oct. 20
95.	*Daulias Luscinia* (nightingale) sings	Apl. 15	Apl. 13
96.	*Saxicola Œnanthe* (wheatear) arrives	Feb. 22	Mar. 12
97.	*Phylloscopus Trochilus* (willow-wren) sings	Mar. 20	Mar. 26
98.	*P. collybita* (chiff-chaff) sings	Mar. 25	Mar. 23
99.	*Alauda arvensis* (sky-lark) sg.	Jan. 27	Jan. 16
100.	*Fringilla cœlebs* (chaffinch) sg.	.....	Feb. 4
101.	*Corvus frugilegus* (rook) builds	Feb. 19	Feb. 20
	——— hatches	Apl. 19	Apl. 10
102.	*Cuculus canorus* (cuckoo) calls	Apl. 14	Apl. 10
	——— changes its note	.....	May 30
103.	*Hirundo rustica* (swallow) arrives	Apl. 12	Apl. 11
	——— flocks	.....	Aug. 7
	——— departs (last seen)	Oct. 27	Oct. 26
104.	*H. urbica* (house-martin) arrives	Apl. 17	Apl. 16
105.	*H. riparia* (sand-martin) arr.	Apl. 27	Apl. 19
106.	*Cypselus Apus* (swift) arr.	Apl. 27	May 5
	——— departs (last seen)	Aug. 19	Sept. 7
107.	*Caprimulgus europæus* (goatsucker) arrives	.....	.....
108.	*Turtur communis* (turtle-dove) coos	May 10	May 4
109.	*Perdix cinerea* (partridge) pairs	Jan. 29	Jan. 24
	——— hatches	.....	June 15
110.	*Scolopax Rusticola* (woodcock) arrives	Oct. 21	Oct. 12
111.	*Crex pratensis* (corn-crake) arr.	Apl. 26	Apl. 23
	Amphibian.		
112.	*Rana temporaria* (common frog) spawns	Feb. 28	Mar. 9

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Dividing the period of observation into three, the average date of the first 20 species, from 22nd January to 20th April, is 7·3 days late; of the next 20, from 26th April to 3rd June, 3·9; and of the last 20, from 6th June to 26th July, 1·2; showing that the state of backwardness was much the greatest in the early spring, little more than half as much towards the end of spring, and not quite one-fifth as much in the early part of summer.

Taking each 10 species in succession, there is but little difference in the state of backwardness for the first three months, but there is then a sudden change for the better, each group of 10 species for the last three months being very little behind the mean in their time of flowering. The average for February is 8·0 days late, for March 6·7, for April 6·2, for May 1·5, for June 2·1, and for July 0·5.

Of the 10 species selected to represent February, there is no difference in the minor groups into which we usually divide them, each group averaging 8 days late. Although the month of January had an average temperature, the weather was wet and dull, and to this the backward state of vegetation in February seems to be due. In February the weather was mild, but very changeable, and still wet and dull. At Harpenden "vegetation was kept healthily back by seasonable weather" in January, and in February "the weather was changeable, and the soil saturated, more from want of sunshine and wind than from excess of rain," and consequently wild flowers were shy of coming into bloom.

Of the species representing March, the 6 flowering within the month averaged 8 days late, and the 4 usually flowering in April, 5 days late. March was a cold and dry month, with a mean temperature lower than that of February, chiefly due to frosty nights, the mean minimum or night temperature being 4½° lower than that of February, and nearly as low as that of January, thus greatly retarding vegetation. At Harpenden "the fine sunny days of March were robbed of their stimulating effect on vegetation by the low night temperatures, and most of the wild flowers were several days later in blooming than in 1884. Seldom," adds our observer there, "has spring corn been got in under such favourable conditions as in the present year."

Of the species for April the 4 which usually flower within the month averaged 5 days late, and the 6 which usually flower in May averaged 7 days late. The first 16 days of April were rather cold, the last 14 were very warm, but their temperature would not sensibly affect the state of vegetation until some considerable time had elapsed. At Harpenden "April was characterised by genial weather, and rarely have the stone-fruited trees presented a more beautiful appearance than in this year, many being literally breaking down with blossom."

The 6 species for May which flower within the month averaged 1 day early, and the 4 usually flowering within the first three days of June averaged 5 days late. Here we see the accelerating effect of the warm weather of the latter half of April, and the retarding effect of the very cold, dull, and wet weather of May. "May

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gave the heaviest rainfall at Harpenden since 1879, and with this excess of rain was registered the lowest mean temperature since 1879. Vegetation was kept so much in check that at the beginning of June it had seldom been observed so backward. Many of the common wild flowers were from 10 to 14 days later in blooming than in 1884."

The first 5 species for June averaged 2½ days late, and the next 5 species 1½ day late, all flowering as usual within the month. Here we see the continued effect of the cold and wet weather of May, but lessening towards the end of June, when the warm, bright, and dry weather prevailing throughout the month appears to have commenced to take effect. At Harpenden "June was extremely variable in temperature. The great extremes of temperature were very hurtful to vegetation, and notwithstanding the immense quantity of bloom on the fruit-trees, the crop in many places was very scanty. No serious deficiency was expected in the wheat crop, but heavy well-packed ears were the exception rather than the rule. At the end of June the crop was a week or perhaps ten days behind that of an average season. Barley was looking well, and oats promised an exceedingly large yield on good land." The first ear of wheat was observed out on the 9th.

The 5 species for July which usually flower in June averaged 1 day late, and the 5 which usually flower in July averaged ½ day early. July was a warm, bright, and very dry month, and thus somewhat similar to June, the stimulating effect of the weather of which appears to have gradually taken more effect, the last four groups of five species each being in succession 2½ days, 1½, and 1 day late, and half a day early.

The few species in our list which flower later in the year appeared at about the average dates; except the ivy (37), the only species for September, which, as in 1884, was out earlier than usual.

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XI.

ON A DIAGRAM FOR A MODEL OF THE SOLAR SYSTEM TO SCALE.

By Arthur Cottam, F.R.A.S.

Read at Watford, 26th January, and at Hertford, 29th April, 1886.

PLATE VI.

The subject of this paper is not, in the usual acceptation of the term, Natural History, which is the history of Nature on this earth on which we live. Our Earth is one of the smaller members of what is called the Solar System, that is, of the system of planets and their satellites which revolve round the Sun as their centre, and it is to the influence of the Sun that most of the phenomena that we study under the title of Natural History are due. I therefore think that a history of nature outside our world ought to interest students of Natural History.

I will begin by asking a question. Have you ever succeeded in realising the relative magnitudes and distances of the Sun and planets? I believe that very few people have, and my object will be to help you to grasp the meaning of the enormous figures with which we shall have to deal. The methods usually adopted to make these huge distances intelligible, are to describe the time an express train or a cannon ball would take to travel over them. Now to my mind it does not convey any definite idea of the distance between the Earth and the Sun to be told that an express train going at the rate of 50 miles an hour would take over 200 years to do the journey. It struck me some two or three years ago that if I could make a model of the solar system to some small scale, I should get a better idea of the matter. I thought I could make small models of the Sun and planets with their satellites, and that I might set them down in a large field at their proper relative distances, and so be enabled to realise what the sizes and distances really are. I am aware that there is nothing new in the idea of making a model or diagram of the solar system, but I believe the idea of making one accurately to scale is a complete novelty. An orrery is a model of a Sun with the planets and their satellites on long arms, so arranged that by clockwork the motions of the various bodies can be imitated, but no attempt has been or could be made to construct an orrery to scale.

The scale that I have adopted for my diagram is the smallest that I could use, so as to make the smaller planets and the satellites visible at all. I have taken a scale of 10,000 miles to an inch, so that every tenth of an inch represents 1000 miles. Our initial difficulty is to obtain some unit by which we can compare our various measurements, and the only unit we can adopt is our own Earth. Our difficulty here is, that being so close to our Earth we cannot easily realise what its size is, but we must endeavour to do so, and for this purpose we will call in the help of our old friend the express train. The earth is 8000 miles (in round numbers) in diameter, its circumference being therefore about 24,000 miles.

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Diameters and Distances of Sun, Planets, and Satellites.

Object.	Mean diameter.	Mean distance from Sun.	Mean distance from Planet.
	Miles.	Millions of Miles.	Miles.
Sun	865,000	.....	.....
Mercury	3,000	36	.....
Venus	7,700	67	.....
Earth	7,900	93	.....
Moon	2,160	.....	240,000
Mars	4,200	142	.....
Deimas	about 10	.....	6,300
Phobos	,, 10	.....	29,400
Jupiter	85,000	484	.....
Satellite I.	2,500	.....	262,000
,, II.	2,100	.....	417,000
,, III.	3,550	.....	666,000
,, IV.	2,960	.....	1,171,000
Saturn	74,000	887	.....
,, Outer ring, exterior	166,000	.....	.....
,, ,, interior	146,000	.....	.....
,, Space between rings	3,000	.....	.....
,, Inner ring, exterior	143,000	.....	.....
,, ,, interior	110,000	.....	.....
,, Between inner ring and globe	18,000	.....	.....
Mimas	under 1,000	.....	117,000
Enceladus	,, 1,000	.....	151,000
Tethys	,, 1,000	.....	186,000
Dione	,, 1,000	.....	238,000
Rhea	,, 1,000	.....	332,000
Titan	3,500	.....	771,000
Hyperion	about 800	.....	934,000
Japetus	under 1,000	.....	2,224,000
Uranus	32,000	1,785	.....
Ariel	Too far away to be measured.	.....	120,000
Umbriel		.....	170,000
Titania		.....	280,000
Oberon		.....	370,000
Neptune	35,000	2,796	.....
Satellite	Not measureable.	.....	220,000

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On a Model to the scale of 10,000 miles to 1 inch.

Object.	Mean diameter.		Mean distance from Sun.		Mean distance from Planet.	
	Feet.	Inches.	Miles.	Yards.	Feet.	Inches.
Sun	7	2·50	.....	.....	.....	.....
Mercury	.....	·30	.....	100	.....	.....
Venus	.....	·77	.....	186	.....	.....
Earth	.....	·79	.....	258	.....	.....
Moon	.....	·22	.....	.....	2	0·0
Mars	.....	·42	.....	394	.....	.....
Deimas	.....	.....	.....	.....	.....	·6
Phobos	.....	.....	.....	.....	.....	2·9
Jupiter	.....	8·50	.....	1344	.....	.....
Satellite I.	.....	·25	.....	.....	2	2·2
,, II.	.....	·21	.....	.....	3	5·7
,, III.	.....	·35	.....	.....	5	6·6
,, IV.	.....	·30	.....	.....	9	9·1
Saturn	.....	7·40	1	704	.....	.....
,, Outer ring, exterior	1	4·60	.....	.....	.....	.....
,, ,, interior	1	2·60	.....	.....	.....	.....
,, Space between rings	.....	·30	.....	.....	.....	.....
,, Inner ring, exterior	1	2·30	.....	.....	.....	.....
,, ,, interior	.....	11·00	.....	.....	.....	.....
,, Between inner ring and globe	.....	1·80	.....	.....	.....	.....
Mimas	under	·10	.....	.....	.....	11·7
Enceladus	,,	·10	.....	.....	1	3·1
Tethys	,,	·10	.....	.....	1	6·6
Dione	,,	·10	.....	.....	1	11·8
Rhea	,,	·10	.....	.....	2	9·2
Titan	.....	·35	.....	.....	6	5·1
Hyperion	about	·08	.....	.....	7	9·4
Japetus	under	·10	.....	.....	18	6·4
Uranus	.....	3·20	2	1438	.....	.....
Ariel	.....	.....	.....	.....	1	0·0
Umbriel	.....	.....	.....	.....	1	5·0
Titania	.....	.....	.....	.....	2	4·0
Oberon	.....	.....	.....	.....	3	1·0
Neptune	.....	3·50	4	722	.....	.....
Satellite	.....	.....	.....	.....	1	10·0

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Our express train, travelling at the rate of 50 miles an hour, would take 20 days to complete the circuit. Our model of the Earth is $\frac{8}{10}$ths of an inch in diameter, and upon the same scale the Moon is only $\frac{2}{10}$ths of an inch. The Sun to the same scale is a globe of 7ft. 2½ins. in diameter. If we place our diagram of the Earth and Moon (the distance of the Moon from the Earth, 240,000 miles, being represented by a space of 2 feet) in front of the diagram of the Sun, it will be seen that there is about one-third of the Sun's diameter outside the Moon's orbit. Perhaps nothing will give you a better idea of the immense distance of the Sun than the fact that to us on the Earth's surface the Sun and the Moon appear to be the same size.

I propose to go into the question of magnitudes first, and afterwards into that of the distances. The members of our system naturally divide themselves into three groups—first, a group of four small planets comparatively near the sun; second, a group of very small planets revolving in orbits close together, and even intersecting one another; and third, a group of four large planets at great distances from the Sun.

The Sun, the centre of the system, has a diameter of 865,000 miles, represented in our diagram by 7ft. 2½ins. Its density is rather less than 1½ times that of water. It revolves on its axis in about 25½ days, and is travelling through space at the rate of six miles a second, carrying all the planets with it. As to what the actual heat of the solar photosphere is we can say very little. It has been calculated that less than one two-thousand-millionth part of the heat emitted by the Sun reaches the earth. The four smaller planets, in the order of their distance from the Sun, are Mercury, Venus, Earth (with one satellite, the Moon), and Mars (with two satellites). The four larger planets are Jupiter (with four satellites), Saturn (with eight), Uranus (with four), and Neptune (with one satellite). Their diameters and distances, with those of their satellites, are given in the accompanying tables (pp. 98, 99), which also show how they are represented in our diagram.

Until 1877 Mars was supposed to be without moons, but in August in that year Professor Asaph Hall discovered, with the great refracting telescope of the Washington Naval Observatory, two minute satellites. These moons are remarkable in many ways. They are the smallest by far of all the known members of the solar system, neither of them exceeding 10 miles in diameter. It is impossible therefore to show them to scale on our diagram, no dot visible to the eye being small enough to represent them. I have indicated their positions on the diagram of Mars. The smallness of these moons is not however their most remarkable feature, their nearness to the planet and the rapidity of their motions being still more curious. All the members of the solar system move from west to east. Our moon moves so slowly that she only passes over a space equal to her diameter in every hour. The moons of Mars, however, move much more rapidly; the outer one, although it must appear to an observer on the surface of Mars to move from

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east to west with the apparent movement of the heavens due to the rotation of the planet on its axis, yet actually moves so rapidly amongst the stars in the opposite direction that its apparent motion from east to west must be very slow. The inner satellite moves with such extreme rapidity that it revolves round the planet nearly four times during each rotation of Mars on its axis. The result of this must be that to an observer on the surface of Mars this moon must rise in the west and set in the east three times during each day and night. I ought not to omit to mention one of the most extraordinary coincidences which has probably ever occurred, and which has reference to these satellites. In 1727 Dean Swift published his 'Travels of Gulliver,' and he describes how, after visiting Laputa, Gulliver went to a flying island inhabited principally by astronomers. Swift makes Gulliver recount the discoveries of these imaginary astronomers, and one of these he describes thus :—"They have likewise discovered two lesser stars or satellites which revolve round Mars, whereof the innermost is distant from the centre of the primary planet exactly three of its diameters, and the outermost five; the former revolves in space in 10 hours, and the latter in 21 and a half." The most remarkable thing in this prophecy is that when, 150 years after it was published, the satellites were discovered, they should be found to be so nearly as Swift had described them, so close to the planet, and with such very short periods, the actual distances being about 1½ and 7 diameters from the centre of Mars.

Saturn is the most wonderful of all the planets. There is no object in the heavens which, seen with a telescope of adequate power, is so fascinating as this. It is at the present time particularly well situated for observation, and the rings are nearly as wide open as they can be. It will be another 30 years before the planet will be again so well seen.

We must now consider the diameter of the orbits of the planets. For this purpose I have drawn a map (see Plate VI), with Watford Church in the centre, and I propose to imagine a model of our sun, 7 feet in diameter, to be upon the tower of Watford Church.

On the scale of 10,000 miles to an inch, the orbit of Mercury, the first planet in order from the Sun, would cross New Street, would pass just south of the "Rose and Crown" and "Essex Arms," through Gibbs's shop, at the back of the Vicarage, between the old Free School and Healey's brewery, by the corner of George Street and Vicarage Road, and through the disused graveyard and the centre of Ballard's Buildings. Mercury completes the circuit in 88 days, moving at the rate of 107,000 miles per hour, or 30 miles in every second.

Venus, the second planet, has an orbit which would cross High Street by the "Green Man," and Queen's Road a little north of the 'Watford Observer' office, and would pass through Chater's shop, through the centre of Mrs. Rivaz's house, and finally through the County Court. Venus revolves round the sun in 225 days, moving at the rate of nearly 22 miles per second.

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This Earth of ours comes next, and its orbit would pass through Buck's and Vine's shops, the old British School in Red Lion Yard, through the new Post Office in Queen's Road, by the junction of Carey Place and Charles Street, across High Street again at Grant's shop, and just south of Southfield House. The Earth's motion in its orbit is at the rate of 18 miles a second. A person situated at the Earth's equator is, although entirely unconscious of it, being whirled through space with three separate motions. There is first of all the Earth's rotation on her axis, which carries the equator round at the rate of 1000 miles an hour, there is then the Earth's motion in her orbit at the rate of 18 miles a second, and the Sun's motion through space, in which all the planets accompany him at the rate of six miles a second. The Earth's orbit is at the present time only slightly elliptical. The Sun is now about 1,500,000 miles from the central point of the ellipse, so that the difference of the Earth's distance from the Sun at the opposite points of its orbit is very nearly 3,000,000 miles. The Earth is nearest to the Sun at the time of mid-winter of our hemisphere. It has been calculated that the eccentricity of the Earth's orbit varies in long periods—that some 210,000 years ago the eccentricity equalled about 3½ times its present value. And this question is one that should be very interesting to students of Natural History, because it may probably explain the occurrence of glacial epochs alternating with periods of tropical heat. It is too abstruse a subject to go into now, but I may mention that it is fully discussed in Dr. Croll's treatise, entitled 'Climate and Time.' The theory is this, that in the periods when the eccentricity of the orbit has been greatest, the Earth's distance from the Sun, instead of varying at opposite seasons as it does now by only 3,000,000 miles, would then have varied by 10,500,000; and the winter of one hemisphere, instead of being, as at present, about one week longer than that of the other, or than its own summer, would have been nearly a whole month longer. "It may therefore be considered very probable that, under such circumstances, glacial epochs would occur, first in one half of the world, and then in the other; with intervals of about 10,500 years between their respective maxima in either hemisphere. And during a period of 200,000 years about ten may have occurred in each hemisphere, some more intense than others, according to the value of the eccentricity of the orbit for the time being; whilst, in alternation with them, a climate of a tropical nature may have extended, first in one and then in the other hemisphere, to a much greater distance from the equator than at present."* The ovalness of the Earth's orbit is now diminishing steadily, and will continue to do so for about 25,000 years to come. It will then begin to increase again until in 50,000 years' time it will have about the same value as at present, and it will not much exceed that value for 100,000 years to come.

The fourth planet is Mars, and he would pass through Watford

* 'The Sun, its Planets, and their Satellites,' by E. Ledger, p. 192.

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House, by the corner of Earl Street and Loates Lane, the bottom of Derby Road, and through High Street station, very nearly to Fearnley Street. The orbit of Mars is one of the most elliptical of all the planetary orbits. He completes the circuit in 687 days, travelling at a rate of 15 miles per second.

I defer for the present mentioning the group of small planets which occupy the space between Mars and Jupiter, and we will consider next the orbit of Jupiter. It is elliptical, and would pass through Watford Station, through the Orphan Asylum, through the gardens of Bushey Hall, across Bushey Station, just south of the Rookery, crossing Cassiobridge Road close to the lodge in Cassiobury Park, just north of Nascot House, and so back to Watford Station. He moves at the rate of 8 miles per second, completing the circuit in about 50 days less than 12 of our years.

Saturn would cross the railway about a quarter of a mile south of the Watford end of the tunnel, would pass north of Bushey Mill, close to Bushey Grange, through Bushey Village close to the east end of the Church, across Watford Heath, south of Oxhey Hall, by Cassio Bridge, and across Cassiobury Park about a quarter of a mile north of the house. Saturn revolves in his orbit in about 30 of our years, exactly in 10,579 of our days, travelling at the rate of 6 miles per second.

Uranus would pass close to Garston Church and Kytes, through the south part of Bricket Wood, close to Munden House, through Letchmore Heath, by Hillfield and Caldicott House, across Bushey Heath close to Windmill Lane, by Hartsbourne across Harrow Weald Common, over Pinner Hill, through Oxhey Wood, close to Moor Park House, between Croxley Green and Rickmansworth, by Red Heath, close to the Hunton Bridge mouth of the Watford tunnel, and through Leavesden. He revolves in rather more than 84 years at the rate of four miles a second.

Last of all comes Neptune, and he would pass just south of King's Langley church, half a mile north of Abbot's Langley, north of Bricket Wood, through Colney Street, by Aldenham Lodge and Newberries, through Elstree, through Stanmore south of the Church, through Pinner Village, across the north end of Ruislip Reservoir, by Harefield Grove, through Mill End, close to Callipers, and by King's Langley Lodge back to the Church. His period is 165 years, travelling at about 3¼ miles per second. This, the slowest-moving of the planets, moves 200 times faster than an express train.

We must now retrace our steps a little to consider the group of small planets which occupy the space between Mars and Jupiter. At the beginning of the seventeenth century a German astronomer named Kepler, having an inquisitive and analytical mind, discovered and enunciated three laws relating to the planetary movements. Although they were discovered then, and were truly laws, the reasons for them were not understood till long after, when Newton discovered the law of universal gravitation. I am not going to enter into the subject of Kepler's laws now, but there was another discovery made by Kepler which led him to make a prophecy. He

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discovered that the distances between the orbits of the planets followed a regular order, each succeeding planet proceeding outwards from the Sun being very nearly double the distance of the last—with one exception—and that was Jupiter, whose distance, instead of being twice the distance of Mars, is nearly four times that distance. And Kepler prophesied that some day a planet would be discovered occupying this vacant place. The progression is not exact, but Bode discovered a curious empyrical law, which represents the distances with remarkable exactness, the fifth space being blank. It will be noticed that Uranus, which was not discovered till long after Bode discovered this remarkable series, fits in very well with the theory. Not so, however, Neptune, whose distance is much less. The probability that a planet would be found to occupy the vacant place became, as time went on, more and more firmly fixed in the minds of astronomers, and in 1800 six distinguished observers, after discussing the matter, resolved to make a persevering search. Piazzi of Palermo, one of the six, discovered, on the 1st January, 1801, a small star in Taurus, which in the course of two or three evenings' observation was found to be moving; its orbit was calculated after a time and it was discovered to occupy exactly the position that Kepler had prophesied 200 years before would be found to be filled by a planet. This new planet was called Ceres. The chief peculiarity of this planet was its minute size. It is probably about 300 miles only in diameter. Two years afterwards Dr. Olbers at Bremen discovered another small planet, with a distance and time almost identical with those of Ceres. In fact the orbits intersect each other. This was called Pallas, and Olbers suggested that they were portions of a large planet that by some convulsion had been rent asunder. The idea led to a continuance of the search. Juno was discovered in 1804, and in 1807 Vesta, both revolving in orbits close to those of Ceres and Pallas. For nearly 40 years no more were discovered, but in 1845 a fifth was found, and from that time to the present some have been found almost every year, until at the present time there are no less than 252 of these small planets known, revolving in orbits between Mars and Jupiter.

Although the subject of this paper is the Solar System, it may be interesting to say a few words about the so-called fixed-stars, of which our Sun is one. We have seen that upon the scale of 10,000 miles to an inch a model of our system would occupy a space over 9 miles in diameter, and it may be interesting to enquire how far off from our model Sun we should have to place the nearest of the fixed-stars. There is no place on this Earth far enough off. The distance of the nearest star is about 30,000,000,000,000 of miles, which would be represented in our model by a distance of over 47,000 miles, or nearly one-fifth of the distance from us to the Moon.

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XII.

WILD PLANTS: THEIR ATTRIBUTES AND NAMES.

By F. G. Lloyd, Hon. Sec.

Read at Watford, 16th March, 1886.

Abridged.

Flowers, and more particularly wild flowers, have, from time immemorial, furnished a theme for the poet; pleasure and attraction for the student of nature; and the source of cure, or alleviation, for many of the ills that man is heir to. The old herbalists maintained the existence of what they called the Doctrine of Signatures, and affirmed that thereby the medicinal uses of a plant were sometimes plainly visible from some part in its external appearance resembling something connected with that which it would cure; thus, the leaves of the St.-John's-wort being full of perforations, signified that it was good for perforations of the body, or wounds; on the spotted and blotched leaves of *Pulmonaria* were traced a resemblance to the lungs, hence it was used for diseases of the lungs, and was named lungwort; the Canterbury-bell, from its throat-like corolla, was supposed to be a cure for sore throat, and was named throatwort; the corolla of *Prunella vulgaris* was thought to resemble a bill-hook, and to be good for wounds caused by that tool, and the plant was therefore known as hook-heal.

Formerly in every village there were herbalists or old women who professed to know the qualities and virtues of the wild plants. In their hands the silver-weed was good for sciatica, ague, or rheumatism; borage cured fevers, venom of serpents, jaundice, consumption, and sore throat; the scarlet poppy was good for pleurisy; the arum or cuckoo-pint was a sovereign remedy for the plague; the violet cured inflammation of the eyes; the periwinkle made an admirable ointment for the skin; the cowslip cured palsy, and was efficacious in cases of "false apparitions," convulsions, cramps, and vertigo; the bugle cured all sorts of body wounds; the pimpernel drew splinters out of the flesh, and was efficacious in disorders of the brain; shepherd's-purse was "the poor man's parmaceti" and cured bruises; toad-flax yielded an infusion good for inflamed eyes; the lady's-smock strengthened the heart; sorrel was good for reducing corpulence; the scabious was excellent in cases of skin disease; the earth-nut cured cough; the self-heal or carpenter's herb healed flesh-wounds; English sage was used as an ointment for the eyes; chickweed was good for cramp; the forget-me-not was a remedy for scorpion stings; house-leek cured freckles; and so on almost every plant that grows might be enumerated.

In more modern and scientific medicine, both in the allopathic and homœopathic pharmacopœia, many of the most important drugs are prepared from well-known plants, such as opium, laudanum, and morphia from the poppy tribe; digitalis from the foxglove; belladonna from the deadly nightshade; aconite from the monks-hood; taraxacum from the dandelion; podophyllin from the thorn-apple; calendula from a marigold; and pulsatilla from an anemone.

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The origins of the various names or nicknames are very curious. In many cases they preserve the memory of supposed virtues, which might otherwise have sunk into oblivion, as in palsy-wort, heal-all, wound-wort, scurvy-grass, mad-wort, bruise-wort, whitlow-grass, gout-weed, and sleep-wort. In some they were derived from a fancied resemblance in some part of the plant, as in horse-tail, hound's-tongue, pheasant's-eye, colt's-foot, lark-spur, stork's-bill, goose-foot, mouse-ear, and shepherd's-purse. Other names were given from purposes or manufactures for which the plants have been used, such as bed-straw, dyer's-woad, broom, birch, mat-weed, glass-wort, salt-wort, soap-wort, and spindle-tree. Some few originated from the approximate time of their coming up, blooming, or being gathered, such as pasque-flower, blooming about Easter; daisy or marguerite, supposed to bloom first on St. Margaret's day, February 22nd; St. John's wort, being gathered about St. John's day, June 24th; the Lent lily blooming during Lent; the Michaelmas daisy blooming about Michaelmas; and the cowslip or herb Peter blooming about St. Peter's day, June 29th; the Germans call it *Schlüssel blümen*, or the flower of the keys, which looks as if there it was connected with St. Peter. Some appear to be from properties possessed by some part of the plants, as in sneezewort, bindweed, nosebleed, catchweed, and poor man's weatherglass. Then we have plants named from supposed baneful effects to certain members of the animal kingdom, amongst them henbane, fleabane, wolfsbane, foxbane, leopardsbane, and flybane. Again, the contrary, from their being a favourite article of diet; thus we have duckmeat, pignut, tenchweed, sheep-sorrel, hare's-lettuce, pigeon's-meat, and goose-grass. A few are named after heathen deities or heroes, as *Daphne*, *Narcissus*, *Glauceum*, and *Centaurea*. A great many take part of their names from the position or places where they grow, as wallflower, brookweed, sundew, windflower, marsh-mallow, heath, and lily-of-the-valley. Some sound as if they had been named by children in their play, such as lords and ladies, butter and eggs, codlins and cream or apple-pie plant, old man's nightcap, go-to-bed-at-noon, goldilocks, and blow-ball.

Following the natural system generally adopted by botanists, I take to night the plants comprised under the class Dicotyledones, so called from their seeds being composed of two (or more) lobes.

Ranunculaceæ.—The Crowfoot tribe takes the name Ranunculaceæ from the Latin *rana*, a frog, through most of the species growing in damp places such as these amphibians frequent. As a rule, their leaves are much divided and their flowers showy; many possess acrid and poisonous properties, monkshood or aconite and hellebore being familiar examples. Amongst the best known is the clematis, a common but very beautiful hedge-climber, growing freely wherever chalk enters largely into the composition of the soil; it is easily distinguished by its greenish-white, sweet-scented blooms in summer, and its lovely tufts of feathered seed-vessels later in the year. From it florists have grown those gorgeous flowers with their large purple, mauve, and white blooms which

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are now such universal favourites in our gardens, and which are mostly increased by grafting on the wild stock. Amongst its names are virgin's bower, hedge-vine, climbers, old man's beard (doubtless from its hair-like seed-vessels), travellers' joy, and love (supposed to be so named from its habit of embracing). There are very few lanes in our county in which it may not be met with. The beautiful anemones, or wind-flowers, so called from their often growing in open positions fully exposed to the force of the wind, are other examples. Hertfordshire is very rich in species, for, in addition to the comparatively common *Anemone nemorosa*, we have the *Anemone Pulsatilla* or pasque-flower (doubtless deriving its name from its blooming about Easter) growing freely in the neighbourhood of Tring, and also found near Royston; the lovely pale blue *Anemone Apennina* blooming near Aldenham, although it is a doubtful native; and the yellow *Anemone Ranunculoides* occurring near Abbots Langley. The buttercup and lesser celandine are both very familiar in our neighbourhood, as elsewhere. The globe flower, although only found in gardens with us, is wild in Scotland, where it grows plentifully, and is called the locken-gowan or cabbage-daisy, from the shape of its flower. The *Caltha*, marsh-marigold, meadow-bouts, or kingcup, one of the most striking of British flowers, may be seen in the neighbourhood of almost every Hertfordshire stream. To the hellebores belongs the christmas rose, which is supposed to be the hellebore of the ancients, so famous as a specific for madness. Closely allied to this genus is the earliest spring flower of our gardens, the winter aconite. The aquilegias, culverworts, or columbines, take two of their names from extremes: *Aquilegia* from *Aquila*, an eagle, to the claws of which its nectary or honey-vessel bears a fancied resemblance; whilst columbine is not named after the heroine of Pantomime, but from the Latin *Columba*, a dove, the nest of which bird its flowers were supposed to be like. In the delphiniums, or larkspurs, again, we get different origins to the names; *Delphinium*, from delphin or dolphin, to which animal a resemblance was traced in its upper leaf; and larkspur, from the spur of the flower resembling that of the lark. The aconite, monkshood, wolfsbane, or Venus' car takes the name monkshood from the shape of the whole flower, Venus' car from the same when the hood is taken off, and wolfsbane from its juice having been put on the points of the arrows used by the Anglo-Saxons in hunting the wolf. Many cases of poisoning have occurred through its roots having been mistaken for horse-radish.

Berberaceæ.—From the bark of several species of the Barberry tribe a yellow dye has been obtained, and the berries, which are acid, are sometimes used for preserving.

Nymphæaceæ.—The roots of some of the exotic species of Water-lilies are roasted and eaten, and in South America the seeds of the *Victoria regia* are eaten, being known as water-maize. In some parts, the common yellow water-lily is called brandy bottle, which is said to be from the flower having a slight smell of brandy, and the seed-vessel being not unlike a bottle in shape.

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Papaveraceæ.—The Poppies are exceedingly numerous and varied in colour, and to them we are indebted for opium, laudanum, and morphia, extracted from the unripe seed-capsules, whereas the seeds are not only destitute of narcotic properties, but are used to manufacture a not unwholesome oil, largely used to adulterate olive-oil. The horned poppy is a very handsome plant which grows on the sandy sea-shore, with peculiar green foliage, large bright yellow flowers, and seed-pods six to ten inches long, which look like flower-stems bare of leaves. Another member of the order is the *Chelidonium*, swallow-wort, or greater celandine, a delicate plant, with small yellow flowers; its juice, an acrid poison of an orange colour, is a popular remedy for warts, has been successfully employed in removing films from the corner of the eye, and is now used in the manufacture of a cure for corns called "celandine."

Cruciferæ.—Of the Crucifers, a large and important order, the common weed known as shepherd's purse, caseweed, toywort, pickpurse, or poor man's parmaceti, is to be found in every part of the world, varying in luxuriance according to the soil, being in poor stony ground but a few inches, and in rich soil growing up to two feet high. The *Cochlearia*, scurvy grass, or spoon-wort, common on muddy sea-shores, was much used before the introduction of lime-juice for the relief it afforded persons suffering from scurvy. Of the cardamines or bitter-cresses, one is the well-known lady's smock, cuckoo-flower, meadow-cress, or spinks. Of the mustards, one, *Alliaria officinalis*, a common wayside weed, with large deeply-veined leaves inclined to heart shape, smallish white flowers, and a peculiar, far from agreeable smell, bears amongst others the peculiar names treacle-garlic-mustard, poor man's garlic, sauce-alone, Jack-by-the-hedge, wormseed, and bank-cress; it was in great vogue during the middle ages as an antidote to all animal poisons.

Resedaceæ.—Of the Mignonettes we have only three English species, one of which is known by the name of dyer's rocket or yellow weed or weld, from its having been used to dye wool yellow, or green when mixed with indigo.

Violaceæ.—The Violets have roots and flowers which have been used as remedies for all sorts of diseases. There is a remarkable botanical curiosity in the structure of the violet which is but little known; it produces flowers both in spring and autumn, but the flowers are very different. In spring they are fully formed and sweet-scented, but they are mostly barren, producing no seeds, while in autumn they are very small, have no petals and no scent, but they produce abundance of seeds. A variety of the violet is the pansy, and it is doubtful whether careful cultivation has done more for any flower than it has for this. Its original name, "heart's-ease," was taken from its supposed potency in love charms; others are, "three faces under a hood," "cuddle-me-to-you," and "kiss-me-ere-I-rise."

Droseraceæ.—The *Drosera*, or sundew, is a curious little plant with leaves covered with red hairs, each tipped with a drop of

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viscid fluid, by which insects alighting on them are retained, while the leaves slowly close over and secure them. It is therefore called an insectivorous plant.

Caryophyllaceæ.—This order comprises the pinks and the chickweeds. Of the former the silenes or catchflys are named from a gum-like juice just below the leaf-axils, often holding small flies and other insects fast. The chickweed derives its name from the partiality most birds have for it. The well-known ragged Robin is a familiar example. The stitchwort or satin-weed takes the former name from its supposed curative power for a stitch in the side, and the latter from the satin whiteness of its flowers, from the shape of which it also derives the name of starwort; in Cheshire it is called breakbone, from its snapping off at the joints, also all-bone.

Malvaceæ.—The Mallows, of which throughout the world there are over 1000 species, all agree in containing a large quantity of mucilage. It is extracted from some species by boiling the roots, and is employed medicinally in allaying both external and internal irritation. The extract of marsh-mallow is much used in France for sore throats.

Tiliaceæ.—From the lime, or linden tribe, we get bast from the under bark of lime, and jute from another plant.

Geraniaceæ.—The Crane's-bills are so called from the resemblance of their seed-vessels to a crane's beak or bill, the best-known example being the herb Robert or stinking crane's bill, a very common plant, distinguished by its elegant pinkish flowers, red stem and leaves in autumn, and unpleasant smell; it is supposed to have got its name "herb Robert" from having been used in Germany to cure a disease called Ruprecht's plague, after Duke Robert of Normandy. From this or some other species of *Geranium* the geraniums of our greenhouses have been derived. Another genus, from which the pelargoniums have been obtained, is *Erodium*, which has been named heron's bill, pick-needle, and stork's bill; in it the seed-capsules become spirally twisted when ripe, often then springing a considerable distance from the parent plant. They are furnished on the inner side with long elastic bristles, and being hygrometric they uncurl when moistened. A twisted capsule, if moistened and laid on a sheet of paper, will, in its efforts to straighten itself, soon crawl an inch or more from the spot on which it was laid.

Balsaminaceæ.—Of the Balsams one species is known as *Impatiens noli-me-tangere* (or touch-me-not), being so called from the valves or outer divisions of the seed-vessel acquiring a very elastic power as the seeds approach maturity, and, when touched, curling up into a spiral form with such force as to spring several feet away from the parent plant; in some districts this is known as "quick-in-hand."

Oxalidaceæ.—The oxalis or wood-sorrel is a very elegant little plant, common in this county, with delicate drooping clover-like leaves, folding together at night, and delicate white or lilac-veined flowers; it is supposed by many to be the plant which was used by

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St. Patrick to illustrate familiarly the doctrine of the Holy Trinity; it abounds in a cooling juice containing oxalic acid, and it is used to remove the stains of ink and ironmould from linen.

Celastraceæ.—The wood of the *Euonymus* or spindle tree was that preferred for making spindles for distaffs, but it is now used for making skewers, from which it is known in some parts as prick-wood, peg-wood, and skewer-wood.

Rhamnaceæ.—The Buckthorns have berries which, when gathered before they are ripe, yield a yellow dye, and when ripe and mixed with lime-water and gum-arabic, the colour known as bladder-green.

Leguminosæ.—We now come to the Bean and Pea tribe, a highly interesting order of plants, containing between 6000 and 7000 species, varying in size from minute herbs to enormous trees with trunks 80 feet in circumference, and varying as much also in structure, properties, colour of flowers, and range of growth. Some afford food of the most nutritious kind, such as peas, beans, and lentils; some, valuable fodder for cattle, as clover, vetches, lucerne, sainfoin, and the carob bean; some, the finest timber, amongst them being rosewood, acacia, logwood, sandal, and Brazil-wood; and others, articles of commerce, and drugs used in medicine, such as senna, liquorice, balsam of Peru, the Tonquin bean, indigo, gum-arabic, tamarinds, dragon's blood, gum-tragacanth, senegal, anime, gumlac, etc. The first genus is *Ulex*, than which no plant is more broadly characteristic of English scenery; it will not thrive in hot climates, and if removed to a much colder one, pines and dies. Linnæus is said to have lamented that he could not keep it alive in Sweden, even in a greenhouse, and it is related that when he first saw it in full bloom on Hounslow Heath, he fell on his knees and thanked God for having created so beautiful a plant. The *Genista* or greenweed has flowers which are used in dyeing, and which, although yellow, yield a green colour; it is this plant which gave the name to the Plantagenet family—"Planta Genista." The broom was so called from its having been used to make brooms of; it contains a bitter principle, not unlike quinine. Of the clovers, trefoils, vetches, tares, etc., we have many interesting examples among our wild plants. Of one, the tuberous bitter-vetch, or heath-pea, the roots are eaten by the Highlanders of Scotland, under the name of "cormeille," a very small quantity being said to allay and prevent hunger.

Rosaceæ.—The Rose tribe is a large and important order, many of the members of which produce excellent fruit, amongst them being almonds, cherries, plums, apricots, strawberries, raspberries, blackberries, apples, pears, quinces, and medlars. The almonds include most of the stone fruits, the bark of many yielding gum, and prussic acid is generally abundant in the leaves and seeds. The blackthorn, or sloe, is well known from its early bloom. The stems are largely used in the manufacture of walking-sticks and whips, the leaves for adulterating tea, the fruit not only for preserving, but also in the manufacture of cheap port wine. The Spireæ, or meadow-sweets, from the beauty and sweet scent of

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their bloom, richly deserve their other names, "queen-of-the-meadow" and bridewort. Our native species are not less beautiful than their more aristocratic cousins, *Spiræa Japonica* and *Spiræa palmata*. Of the Potentillas, or strawberry group, our most familiar examples are the common, though beautiful, silverweed or goosegrass, and the barren strawberry, one of the earliest spring wild flowers, much resembling, and often taken for the wild strawberry, but having the flower-stems more erect and the petals entire. The real strawberries, and the blackberries and raspberries, belong also to this order. Of the Rosidæ or rose group, the rose has ever been a favourite flower with poets as with Oriental writers. In the East it is supposed to be the chosen flower of the nightingale; Englishmen glory in the rose as their national emblem, although at one time it was the symbol of civil war and bloodshed. The Pomeæ or apple group include the apple, pear, quince, medlar, service, mountain-ash, and hawthorn. The fruit of the mountain-ash and of some other species yields malic-acid, and the leaves yield prussic-acid in as great abundance as the laurel.

Onagraceæ.—The Willow-herbs include some plants the leaves of which are used to adulterate tea, and in Kamskatchka are used as tea. To this order belongs the *Œnothera* or evening primrose, of which the root is eatable. Originally it was called "*onagra*" (signifying asses' food), and was eaten after dinner to give flavour to wine, as olives are now, whence it derives its present name, *Œnothera* or wine-trap.

Lauraceæ.—This order only includes one European plant, the bay-tree, but from one species cinnamon is obtained, and from others, cassia, camphor, nutmeg, and mace.

Cucurbitaceæ.—The gourd tribe inhabits principally the hot regions of the globe; the properties of this order are in many instances exceedingly violent, the drug colocynth being a familiar example. The bottle-gourd is very poisonous; it is recorded that some sailors were poisoned by drinking beer that had been standing in a flask made of one of these gourds. The only plant belonging to this order that is a native of Britain is the white bryony, the root of which is used in medicine. The spurting cucumber, so called from the force with which it expels its poisonous juice when ripe, is a very dangerous drug; on the other hand, we have belonging to the same order, the melon, the cucumber, and the vegetable marrow.

Crassulaceæ.—This order comprises plants inhabiting most parts of the world, such as the houseleeks, the cacti, and stonecrops. They are remarkable for their thick fleshy leaves, and they grow in the driest situations, where not a blade of grass or a particle of moss can live, requiring no nourishment but that which they derive from the atmosphere. It is said that one British species, *Sedum telephium*, will grow for months if suspended by a string from the ceiling, without being supplied with water. It is sometimes called livelong and "midsummer-man," taking these names from an old

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custom of country girls, who used to set up two plants of it, one for themselves and one for their lover, upon a slate or trencher, on Midsummer Eve, and then estimate their lover's fidelity by his plant living and turning to theirs or not.

Saxifragaceæ.—The Saxifrages, sometimes called by the literal translation of the Latin, "stonebreaks," from the roots disintegrating the rocks in the crevices of which they grow, are a numerous order, and some of them have very beautiful flowers. The best-known species, perhaps, is London pride, which takes its name, not from the town of London, but from a member of the firm of London and Wise, florists, who introduced it into cultivation in the early part of the last century.

Umbelliferæ.—This order is so named from the flowers being produced in umbels or flat bunches, the elderberry being a familiar example. The members of the order vary greatly in their properties, the roots, leaves, stalks, and seeds being variously used, some as food and condiments, and others as medicines, while some are very poisonous.

Loranthaceæ.—The flowers of this order are as a rule inconspicuous, although one species, growing in the vicinity of St. George's Sound, has an abundance of bright orange-coloured flowers and is called the fire-tree. To the mistletoe great virtues were attributed by the Druids.

Caprifoliaceæ.—The Woodbines comprise shrubs and plants of very different habits, amongst them being the common elder, which in some countries is looked upon as possessing valuable medicinal properties; in Russia the flowers are much sought after, a decoction of them being used for colds. The guelder-rose, snowball, or water elder, and the honeysuckle or woodbine with its lovely blossoms and delicious fragrance, which flourishes so in our country lanes, are other examples of this order.

Rubiaceæ.—The Madder tribe is a very large one, some of the members of which are of the highest utility to man, both as food and medicine, amongst them being the coffee-tree, and several plants from which Peruvian bark and quinine are obtained. This order also includes the *Galium* and sweet woodruff.

Dipsaceæ.—One member of the Teasel tribe, the teasel or fuller's thistle, furnishes, in its large flower-heads, the means of properly combing wool in the manufacture of cloth; the heads are set in frames, and the stiff hooks of the teasel catch up and remove all loose particles of wool, but give way when held fast by the substance of the cloth. This is one of the few manufacturing processes which cannot, up to the present, be done by mechanical means alone.

Valerianaceæ.—The roots of *Valeriana officinalis*, which grows plentifully on chalk cliffs, and on our railway cuttings, are used in medicine. They have a remarkable attraction for cats, and in India are used for trapping tigers. *Valeriana Jatamansi* is the spikenard of Scripture.

Compositæ.—Of this order the daisy group includes the coltsfoot, bull's-foot, horse-hoof, or cough-wort, taking the first three

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names from the shape of the leaves, the last from its having been much used as a remedy for coughs. The cotton of the leaves was formerly used as tinder. The flea-banes, the asters, the groundsels, the leopard's-bane, and the common daisy or "eye-of-the-day," also belong to this order. Chaucer says,

> "One called eye of the daie,
> The Daisie a flowre white and rede,
> And in French called La bel Margerite."

The daisy is essentially the children's flower, and perhaps its prettiest name is a Scotch one, the bairnwort. Amongst its names we find marguerite, herb margaret, and wound-wort, this last from its soft downy leaves having been used instead of lint for dressing wounds. The feverfews were formerly much used in medicine as a febrifuge, and are now used as an insect-powder, supposed to be particularly objectionable to mosquitos; my personal experience in Algeria being that it has rather attractive powers than otherwise. The chamomiles are largely used in medicine, deriving the name from the Greek, signifying ground-apples, from their smell being supposed to resemble that of fresh apples.

Campanulaceæ.—The Bell-flowers are mostly slightly shrubby plants, with a milky, bitter juice, and ornamental flowers, but of little use as food or medicine. They include the beautiful hairbell or lady's thimble, which is really the bluebell of Scotland.

Ericaceæ.—The Heath tribe chiefly consists of shrubs or small bushy trees with evergreen leaves and highly ornamental flowers, and they often cover large tracts of country. The genus *Vaccinium* includes four English species with slightly acid berries, to which the names of cranberry, whortleberry, bilberry, and whinberry have been applied.

Apocynaceæ.—The British examples of this order are herbaceous plants with showy flowers, the Periwinkles. Most of the members of the order abound in a milky juice, and a large number are poisonous. *Taughinia venenifera*, a native of Madagascar, is one of the most deadly vegetable poisons, one seed being sufficient to kill twenty people. The "hya-hya" is one of the "cow-trees," affording a large quantity of sweet and wholesome sap, which is used in the place of milk. Several species produce India-rubber of good quality. They are remarkable for the intensely bitter principle existing throughout every part of them, hence they are valuable tonic medicines.

Gentianaceæ.—The Gentians are mostly herbaceous plants, and many have large and brilliantly-coloured flowers. They are distributed throughout all climates.

Convolvulaceæ.—The Bindweed tribe is an extensive and highly valuable order of plants, mostly herbaceous climbers, with large and beautiful flowers, many ranking high as medicinal plants. From the roots of *Convolvulus scammonia*, a Syrian species, scammony is obtained, and from the resin abounding in the roots of several others, jalap.

Boraginaceæ.—The Borage tribe includes several of our wild

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flowers, most of them bearing their flowers in spikes or clusters. The prevailing colour is blue or purple, and in many the bloom, when first opening, is of a reddish hue, so that it is not unusual to see flowers of different tints in the same spike or cluster. One species, the viper's bugloss, was supposed to resemble the head of the viper in its seed, and also to cure the bite of the viper, by the doctrine of signatures. The most interesting genus in this order is undoubtedly the *Myosotis*, scorpion-grass, mouse-ear, or "forget-me-not," one of the most beautiful of our wild flowers. It may also be called a most poetical flower, it being supposed to have taken its name from a legend of a knight, who, in trying to gather its blooms for his ladylove, sprang into a deep and quick-flowing river. As the stream overpowers and carries him away, he throws the flower to the lady, and with his last breath exclaims, "Forget-me-not." It seems a pity to disturb so pretty a legend, or the idea that so sweet a flower should always have borne so sweet a name; but there can be no doubt that this flower is not the original forget-me-not, and that the name originated in a far less poetical manner. This plant has only borne the name about sixty or seventy years (from about 1821); from the middle of the fifteenth century to that date the name was given in Germany, France, the Netherlands, and England, to *Ajuga Chamæpitys*, the ground-pine, field-cypress, or goutweed (one of the bugles), which derived the name from being so nauseous, that once any one had tasted it, it was a certain case of "forget-me-not." Before the fifteenth century there is no doubt that this name was given to the germander-speedwell, from the rapidity with which its beautiful flowers fall to pieces. The speedwells derive their name from the fugitiveness of their blossoms.

Solanaceæ.—Of the Nightshade tribe some members are most poisonous, others being wholesome and nutritious vegetables. The most important is the potato, first successfully introduced into this country by Sir Walter Raleigh in 1586.

Scrophulariaceæ.—The Figworts include some of our handsomest wild flowers, such as the fox-glove (*Digitalis*) and snap-dragon (*Antirrhinum*). The fox-glove contains a powerful poison used in medicine to control the action of the heart.

Labiatæ.—The Labiates are remarkable for in no single instance possessing injurious properties. Many are fragrant and aromatic, some, such as lavender, being well known for their perfume; others, such as peppermint, thyme, mint, sage, balm, and rosemary, are used in medicine and as condiments.

Primulaceæ.—The Primrose tribe is a well-known one, inhabiting mostly the cooler regions of the northern hemisphere, and being mostly early bloomers, as the name primrose, taken from "prima rosa," the first (or earliest) rose, denotes.

Plantaginaceæ.—The Plantain tribe is best known in the country by the common plantain used for bird-seed, and from which in France a mucilage is made, used to stiffen muslin with.

Chenopodiaceæ.—The Goosefoot tribe is so called from a fancied resemblance of the leaf to a goose's foot.

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Polygonaceæ.—This order includes the buckwheat, the persicarias, the water-pepper, the docks, the rhubarb, and the sorrels, of which the latter is largely cultivated on the Continent as a vegetable, under the name "oseille," being cooked like spinach.

Euphorbiaceæ.—The Spurges are distributed over the tropical and temperate regions of the globe, and, although differing considerably in many respects, yet nearly all agreeing in being furnished with a juice, often milky, which is highly acrid, narcotic, or corrosive. The British spurges are remarkable for the singular structure of their green flowers, and their acrid milky juice, a small quantity of which placed upon the tongue produces a burning heat in the mouth and throat for some hours. The leaves of the Irish spurge are used by the peasants, bruised, for stupefying fish, upon which they have a most powerful effect. The three British genera, *Euphorbia* (spurge), *Buxus* (box), and *Mercurialis* (mercury), are more or less poisonous. The dog-mercury has a powerfully poisonous effect on dogs, and the boxtree is poisonous to cattle; in some parts of Persia, where it is very plentiful, large numbers of camels are killed annually by browsing on it. The juice of the euphorbias has been found useful in protecting iron and steel from rust, a fact which was discovered through the tools used in cutting down some euphorbias in Natal not rusting where the juice had touched them.

Urticaceæ.—The Nettle tribe takes its name from the stinging nettle, a plant generally looked upon as worse than useless, although, from the quantity of fibre it contains, it is quite possible that it may become a cultivated and useful plant, as are many of its relatives, such as the hop, hemp, fig, and mulberry.

Coniferæ.—The Fir tribe is of enormous service to man, providing a large quantity of timber, a large proportion of the raw material used in the manufacture of paper, Stockholm tar, pitch, and also resin and turpentine. Amongst the members of the tribe are the pine, fir, larch, juniper, and yew; and it is to this tribe that we are chiefly indebted for coal. Dr. Carpenter says that "the immense masses of coal which now contribute so much in every way to the comfort and social improvement of the human race are but remains of vast forests chiefly if not entirely of the pine and fir kind."

This order completes the first class, the Dicotyledones, and it will easily be understood that it is extremely difficult to condense so vast a subject into an hour's paper, and that in order to do so, not only must very little be said of those plants which are mentioned, but that the mere mention of very many plants of great interest must be omitted altogether.

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XIII.

MISCELLANEOUS NOTES AND OBSERVATIONS.

Read at Watford, 11th May, 1886.

Geology.

Earthquake in the West of England felt at Hertford.—During the morning of January 20th, 1886, a gasalier was observed to be in slight but continuously tremulous vibration. This was first noticed about 11 a.m., or a little earlier, and continued till it ceased to be observable towards the end of the afternoon. The occurrence was remarked on as a very peculiar and unusual one at the time. The next morning the following paragraph was observed in the 'Standard' (January 21st):—"Another earthquake occurred in the West of England yesterday morning. At Bodmin the houses were so much shaken as to startle the inhabitants. At Mevagissey the phenomenon was characterised by a loud rumbling noise. In some of the houses the beams and flooring creaked like the straining of a ship in a rough sea. At St. Blazey the inhabitants were so shaken in bed that they arose in fright. Buildings swayed to and fro and tottered. The shock took place at half-past six, and lasted about six seconds."—*C. E. Shelly, B.A., M.B., Hertford.*

Section at the Well and Boring made at the Colne Valley Water Works, Watford, in 1885.—The well is sunk on a site about 190 feet above Ordnance datum, and the water rises to within 18 feet of the surface. The well is 6 feet in diameter and 43 feet deep. In the bottom is an 18-inch boring 657 feet deep, making a total depth of 700 feet. The well and boring are lined to a depth of 108 feet above Ordnance datum. The following strata were passed through:—

	FEET.
Made ground	5
Soft chalk and flints	86½
Hard chalk and flints	26
Soft chalk and flints	17½
Soft chalk with very few flints	26
Hard grey chalk rock	8
Soft chalk	3½
Very hard blue bind	6
Hard chalk rock	16
Soft blue clay	1
Hard chalk with thin layers of clay	240½
Blue clay	1½
Hard chalk	4½
Soft chalk with thin beds of blue clay	80
Hard chalk and dark clay	50
Chalk Marl and dark clay	114
Upper Greensand...	5
Gault	9
	700

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The bottom of the boring is 510 feet below Ordnance datum. The well and boring are 56 yards from the old well and boring made in 1873, and the two wells are connected by a tunnel at a level of 147 feet above Ordnance datum, so that the water from the new boring passes to the old well, where it is pumped out. The yield from the new boring is about 600,000 gallons a day. The work, which took three months to complete, was carried out by Messrs. Hill and Lester, of Great George Street, under the superintendence of Mr. John F. La Trobe Bateman, C.E.—*William Verini, Watford.*

Section at the St. Albans New Water Works.—The boring operations which have been going on recently at the bottom of Holywell Hill have resulted in a continuous supply of excellent water at a depth of 150 feet, at a temperature of 50° Fah., the quantity obtained being 16,000 gallons per hour. The boring is lined down for the first 50 feet with screwed round wrought-iron tubing. The strata passed through were as follows:—

	FEET.
Surface mould	3½
Gravel, sand, etc.	3½
Chalk flints	3
Red gravel and sand	14
Chalk and flints	37
Hard flint	1½
Chalk	3½
Chalk rock	1
Chalk	83
	150

The pumping work is being carried out by Messrs. G. Waller and Co., of the Phœnix Engineering Works, Southwark, for the local Water Company, of which Mr. A. F. Phillips is engineer.—*From the 'Herts Mercury.' (Communicated by John Hopkinson, Watford.)*

Section at the Sewage Farm, Watford Fields.—A chimney-shaft has lately been built at the engine-works, and as a somewhat deep excavation had to be made so as to get a solid foundation, I thought a notice of the section would be of interest. I may remark that the situation is so low, being below the level of the River Colne, and the soil so porous, that great difficulty was found in keeping out the water—at least 100,000 gallons being pumped per hour. It was noticed that water rose in the sumpt hole higher than the water in the adjoining ditch, only 10 feet from it. The section was as follows:—Broken ground, 3 feet; clay and soil, 18 inches; peat bog, 4 feet 6 inches; then flints and gravel. Some bones, probably of the red deer, and some stags' horns, were found in the peat bog. I think there can be no doubt that this was the bed of a lake. The gravel is water-worn, but higher up it is angular. A few drifted fossils are found in it.—*A. T. Brett, M.D., Watford.*

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Botany.

Flowering Plants observed in Hertfordshire during the years 1884 *and* 1885.—I am sorry to have to report that during the past two years I have received very few records of the rarer plants occurring in Hertfordshire. In 1884 seven species were recorded by Mr. A. F. Griffith, of Sandridge; one by Miss K. Chennells, of Wheathampstead; one by Mr. Hopkinson, of Watford; and two by myself. In 1885 I have had records from a Bedfordshire botanist only, Mr. James Saunders, of Luton, who sends a list of eleven plants he has found in the north-west corner of Hertfordshire. I trust that during the present year members of our Society who take an interest in botany will not fail to send me a list of the rarer plants they may observe in their country walks. The following are the plants recorded, arranged as in previous reports:—

Aquilegia vulgaris.—Corn-fields, Lilley.—*Saunders.*
Stellaria graminea.—Near Smallford Station.—*Griffith.*
Melilotus alba.—Gravel-pit between Bushey Mill and Watford.—*Hopkinson.*
Astragalus hypoglottis.—Lilley Hoo.—*Saunders.*
Hippocrepis comosa.—Caddington Downs.—*Saunders.*
Vicia lutea.—Railway-bank, Berkhamsted.—*Griffith.*
Lythrum hyssopifolium.—Putteridge (casual).—*Saunders.*
Parnassia palustris.—Near the Lea, Cold Harbour.—*Saunders.*
Galium cruciatum.—Near Cheapside Farm, Sandridge.—*Griffith.*
Campanula glomerata.—Meadow near Marford Bridge.—*Griffith.*
Pyrola minor.—Woods near Market Street.—*Saunders.*
Vinca minor.—Near Bricket Wood.
Cuscuta trifolii.—Battler's Green Farm.
Hyoscyamus niger.—Wheathampstead Hill (in great profusion).—*Miss Chennells.*
Lathrea squamaria.—Near a farm-house west of Redbourn.—*Griffith.*
Mentha sylvestris.—East Hyde.—*Saunders.*
Ajuga chamæpitys.—Chalky field, Hexton Hills.—*Saunders.*
Scutellaria galericulata.—Near Wheathampstead.—*Griffith.*
Holtonia palustris.—Pond near railway south of Hatfield Station.—*Griffith.*
Spiranthes autumnalis.—Chalk hills, Hexton.—*Saunders.*
Epipactis latifolia, var. *purpurata.*—Near Symonds Hyde Woods.—*Griffith.*
Butomus umbellatus.—By the Lea, East Hyde.—*Saunders.*
—[*Miss*] *Ada Selby, Battler's Green, Aldenham.*

Araucaria imbricata bearing Cones.—In 1885 there were many letters in the 'Times' and other London papers speaking of *Araucaria imbricata* having borne cones, as if it were a remarkable occurrence, and it was thought to show a very mild climate. Reference was made to some in the Isle of Wight and in Devon-

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shire. I made enquiries in this neighbourhood, and I found that the tree at Mr. T. Cotterell's, The Stanboroughs, Watford, and that at Mr. S. Noakes's, Bushey Heath, had borne cones. Mr. Noakes says, "The tree is about 38 years old, and about 35 feet high; it has borne cones, 10 to 20 each year, for the last three years, and this year I counted, with a binocular, 150. It is a female, and although some of the seeds are well filled, they are of course barren." The tree at Mr. Cotterell's has never borne cones till this year.—*A. T. Brett, M.D., Watford.*

Zoology.

Reptiles recently observed near Watford.—I have to record the capture of a common slow-worm or blind-worm (*Anguis fragilis*), in Dr. Brett's meadow, the week before last. Both vernacular and classific synonyms are misnomers, since it is not blind, can be remarkably agile in its movements when it likes, and, though certainly brittle and serpentine in form, it is not a snake, but one of the leg-less lizards. The specimen, a male, is somewhat unusual in coloration, and has not fed since it was entrusted to me. It must have shed its skin very shortly before its discovery. Mr. T. Villiers tells me that, a few days ago, he saw a ringed snake (*Propidonotus natrix*) about 4 feet long, near Aldenham. This is rather a large specimen. I have seen one which measures 5ft. 8in. (the longest, I believe, on record) and as thick as a broomstick, from the New Forest; the female attains the greater size, but this was a male. It is rather singular that a snake should have left its winter quarters while the weather is so cold in this neighbourhood; they usually require a much higher temperature to induce them to emerge from hybernation than that which impels them to retire in the autumn. There is some reason to believe that a colony of young snakes is located in, or in the immediate vicinity of, the pond at the top of the town. Two summers ago a gentleman lost a number of adult specimens near that spot. Some of these appeared from time to time in the surrounding gardens, and were humanely protected by the owners, but at length fell victims to the genus "boy." It was evident, from their increased size, that they had fattened freely on frogs, slugs, or fish. One must have laid some eggs, for about 20 newly-hatched snakelets were collected; these were again set free. Since they are perfectly harmless, for there is no more inoffensive creature on earth than the common snake, it is to be hoped that they will be spared the usual persecution, if discovered.—*Arthur Stradling, C.M.Z.S., Watford.*

Badgers (*Meles taxus*) *in Hertfordshire.*—I have been making enquiries as to the badgers in the neighbourhood of Watford, and I fear that, if not extinct, they are now of very rare occurrence. A keeper tells me there was in a park near here a litter of six in 1881, and a litter of five in 1882, both about March. The female badger was caught in 1882 and let loose, and again caught in

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1883, and then sent to the Zoological Gardens. A male was killed in 1883, being trapped; its weight was 28½lb. There is no trace of badgers now. The 'Herts Mercury' of the 27th February, 1886, says:—"A badger was caught in Lord Cowper's park at Panshanger last week. It is in good condition and weighs 25lbs."—*A. T. Brett, M.D., Watford.*

A Fox-terrier catching an Eel.—When passing the bridge at Bushey Mill, Watford, on the morning of the 17th of September, 1882, I noticed my fox-terrier dive into some rushes on the side of the River Colne, and I went to see what was the matter, when to my surprise an eel was brought to the surface, and with the terrier's assistance and that of a gentleman who was passing, I managed to get the eel on *terra firma*. As the eel was not very much the worse for the "shaking up," I took him home with the view of sending him to some aquarium. Being a fisherman of many years' experience, I considered this a very fine specimen of the fresh-water silver eel. I got my friend safely home, and placed him in a foot-bath, half full of water, and he commenced disporting himself about as if nothing had happened, so I left him in the garden. After dinner I thought I would pay my new importation a visit, when to my great astonishment the dog was pulling him round the garden, having fetched him from his temporary abode. Of course the eel soon died after the second scrimmage, and I had him set up by Mr. Bowers, of Watford, who, by the bye, has shown good taste in dealing with a difficult subject. The eel weighed 5½ pounds, and measured 38 inches in length. I may add that the dog has shown, on many occasions, more intellectual power than is generally possessed by this class of dog.—*J. P. Gwynne, Watford. (Communicated by Dr. Brett.)*

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XIV.

NOTES ON SOME HERTFORDSHIRE CARICES.

By the late R. A. Pryor, B.A., F.L.S.

*Read at Watford, 10th May, 1877.**

In the preparation of the Flora on which I am engaged, I have found it necessary to pay considerable attention, among other doubtful points, to those connected with some of our more interesting Carices. The following notes are based on the examination of a number of specimens preserved in the collection of the late Rev. W. H. Coleman † and in other herbaria, but more especially in the growing state.

I.—Carex lepidocarpa, Tausch.

After some consideration and the comparison of numerous examples from different parts, I have come to the conclusion that we have but one form of *C. flava* in the county, and have little hesitation in reducing both the "*flava*" and "*Œderi*" of the 'Flora Hertfordiensis' to *C. lepidocarpa*, Tausch. Variable as this sedge is in appearance, and ranging from eighteen to barely three inches in height, it can, I believe, be readily recognised, at all events in the living state. Besides the usually longer-stalked male spikelet, and the roughness of the upper part of the stem, the perigynia are generally not above half the size of those of *C. flava*, and the shorter beaks are either almost straight, or have rather the appearance of having been forcibly bent downwards, instead of having the natural and almost double curvature of those of the genuine plant.

II.—Carex fulva, Goodenough.

The history of this supposed species has been always attended with many circumstances of obscurity, and the name has been used in widely different significations.

It was originally described by Goodenough in the second volume of the 'Linnean Transactions,' where he characterises it in the following terms:—"C. vagina infima subdimidiata, superioribus subæquantibus, spicis fœmineis duabus oblongis acutis, capsulis rostratoacuminatis: *Carex distans*, 'Fl. Dan.,' t. 1049.‡ prope Eaton, juxta Shrewsbury, in agro Salopiensi: Rev. E. Williams."

And after a detailed description, which it is not necessary to quote, he proceeds at some length to contrast his new species with that immediately preceding it, as under—

* 'Journ. Bot.,' N.S., vol. v, p. 365. This paper, although read before the Society some years ago (see 'Trans. Watford Nat. Hist. Soc.,' Vol. I, p. lvii), may be of interest in connection with the author's 'Flora of Hertfordshire,' which will shortly be published by the Society.—Ed.

† This collection is now in the possession of the Society, with those of the late Rev. R. H. Webb and the author.—Ed.

‡ This figure has been variously applied, and was considered by Smith to represent his *C. speirostachya*, in spite of the "pointed scale accompanying the fruit" ('Eng. Fl.,' vol. iv, p. 99); Hoppe, however, seems again to refer it to his *C. fulva*.

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"This plant is scarcely removed from *C. flava*. However, it differs from it in having the angles of the culm sharp and rough; the female spikes are remote, oblong, and acute, not round; the lowermost is supported by a long foot stalk, half of which nearly appears above the vagina. Besides, it has scarcely ever more than two female spikes. The lowermost bractea is erect, and not divaricated. The capsules are not divaricated, but patent, and are slightly divided at the summit. I regret that I have had no opportunity of cultivating it. I am indebted to the Rev. Mr. Williams, of Eaton, near Shrewsbury, for my knowledge of this plant as a native of Britain. I have received it from America and Newfoundland, but I never understood till very lately that it was an inhabitant of our country." *

In this description the roughness of the culm is a character, at least in a lesser degree, common to *C. lepidocarpa*, which also has not unfrequently but two female spikelets, or occasionally even only one; and in the case, as perhaps usually happens, of a greater number, the lowest spikelet is often considerably removed from the rest. On the other hand, both in the number of the spikelets, and in the length of the lowest bract ("culmum plerumque æquans," Good. *loc. cit.*), the plant here described recedes clearly from *C. Hornschuchiana*, Hoppe, with which Goodenough's species has been identified by some Continental botanists, and with which it has, as I believe, been generally confused among ourselves. The figure (tab. 20, fig. 6 †), as was usual at that period, is drawn from a plant with unripe fruit, and adds but little to our knowledge of its character, and, except for the longer sheath of the lowest bract, and the exserted pedicel which accompanies it, might well have been taken from an ordinary example of immature *C. flava*.

A new species was thus introduced into our flora, closely allied to *C. flava*; nor was any other relationship indicated by its author. The question was, however, reconsidered, and three years later, and after the receipt of additional specimens from the same corre-

* 'Linn. Trans.,' vol. ii, p. 177. Read 3rd April, 1792.

† Goodenough's plate is copied by Schkuhr ('Riedgräser,' tab. T, No. 67); he has added, however, a figure of *C. Hornschuchiana*, from which the details, and especially the very characteristic female glume, are taken. In the copy that I have seen (the Linnean Society's, formerly in the possession of J. Woods) the difference of colouring in the two plants is well preserved. Schkuhr quotes *C. trigona* of Allioni ('Fl. Ped.,' 2325) as a synonym, a name that, if rightly referred, would take precedence (1785) of that of Goodenough. The female spikelets are said to be "manifeste et perfecte trigonæ, qua nota facillime a proximis speciebus distinguitur," which does not apply to any British specimens of the so-called *fulva* that I have seen. In the figure (tab. 89, f. 4) the upper bracts are very short, while the lowest is disproportionally long, and greatly exceeds the male spikelet, but this perhaps is an accidental deformation; in other respects it is not unlike *C. Hornschuchiana*. The same synonym has been referred by Reichenbach, I know not on what grounds, to his *fulva*, which he distinguishes from *Hornschuchiana*. On the other hand, Degland quotes *C. trigona* as well as Haller's "C. Culmo foliisque firmis erectis, spicis fœmineis quaternis longe petiolatis erectis" ('Nomencl.,' n. 1383) under his *C. fulva*, which is not that of Reichenbach, and the description obviously cannot be applied to Goodenough's plant.

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spondent, Goodenough took occasion in his second paper on our native Carices to give expression to a decided alteration in his views. "When," he remarks, "I inserted *C. fulva* as a distinct species, I did it in consequence of a variety of specimens sent me by my friend Mr. Williams, all of which being nearly the same as that represented in the figure given in my former paper, and entirely corresponding with my foreign specimens, I concluded that I had nothing further to discover. Mr. Williams has since sent me specimens of more forward growth, which prove it to be a variety of *C. flava*. In the figure of my former paper, it is represented with three female spikes; it very seldom has more than two. I would wish, therefore, to correct the article of *C. fulva*, and make it a variety of *C. flava*:—*C. flava*, var. β, spicis fœmineis duabus."* And he would thus appear to have relied mainly upon the reduced number of spikelets to differentiate his former *fulva* even as a variety from *C. flava*. Accordingly, in the following year (1796) we find Withering arranging *C. fulva* as var. 2 of *C. flava*, and supplementing his notice with the important statement that "Dr. Goodenough has authorised me to say that having cultivated the *C. fulva* he is convinced of its being only a variety of the *C. flava*." †

Such, then, was finally the result of the application of the conclusive test of cultivation to the British specimens of the supposed new species; while, of the American examples, "It is remarkable," to quote the suggestive words of the illustrious monographer of the genus, "that Goodenough originally received *C. fulva* from America, and that the late Mr. B. D. Greene found it some years back near Boston, and that no one has since met with it there or elsewhere in the States." ‡ Whatever view, therefore, we take of this identification of the Boston plant, it may well be questioned whether the American *fulva* was anything more than a transitory phase of some other species.

There can be little doubt that the claims of *C. fulva* to specific rank were fully and finally withdrawn by their original author, as having been founded on a misconception resulting from the examination of plants of immature growth. Sir James Smith, however, seems to have been of a different opinion. In his 'Flora Britannica' (1804) he remarks of *C. fulva* (vol. iii, p. 991), "videtur species a *C. flava* distinctissima"; and adds, "very common in Mearnshire [Kincardine]. . Prof. S. Beattie, junr.," to Goodenough's previously-recorded station. The two localities are repeated without any addition in his 'English Flora' (1828, vol. iv, p. 108), where it is said to be "not very unfrequent," and is stated to be "more allied to *C. distans* and *speirostachya* than to *flava*," and to be undoubtedly very distinct, although confounded with all three species, so that neither the recorded places of

* 'Linn. Trans.,' vol. iii, p. 77. Read 6th January, 1795.
† 'Bot. Arr.,' ed. 3, vol. ii, p. 99.
‡ Boott, 'Illustr. Carex,' pt. iv, p. 138.

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growth nor the synonyms can be relied on. In his 'English Botany,' No. 1295,* published in the same year as, and probably immediately after, the issue of his Latin Flora, Smith has further noticed that "some erroneous specimens led the accurate Dr. Goodenough to reduce this (*C. fulva*) to a variety of *C. flava*, but we have traced the cause of this mistake." I have been unable to learn anything of the authority for this statement, which would imply yet another change of opinion on the part of the original describer. It is not easy to accept Smith's solution of the difficulty, as his remarks are in apparent conflict with the earlier as well as the later views of Goodenough, nor is it certain that his own judgment was always consistent with itself. It is difficult to see how the same species can be "scarcely removed from *C. flava*," and yet not only "very distinct from it," but "more allied" to *C. distans*. Nor has an examination of contemporary herbaria served to throw much light on the points in question.

In the first place, it is remarkable that there should be no British specimens of this controverted sedge among Sir J. Smith's own plants. A sheet marked "*flava*" from Teesdale has at some subsequent period (not by Smith) been placed among the "*fulvæ*," with a query; no doubt, however, can, I think, attach to the correctness of the original name. There are three sheets marked "*speirostachya*," including the original specimens from David Don; and one labelled "*C. fulva* diversissima a *flava*"; the only British examples from "Aberdeen, Prof. Beattie, 1799," and "Scotland, Mr. Mackay, 1796," have been altered by Dr. Boott† to *speirostachya*, an identification in which I have no doubt (if it is necessary to say so) that he was correct; they are quite indistinguishable from those on the former sheets. Thus *C. Hornschuchiana* (*speirostachya*) seems to have completely absorbed the reconstituted *fulva* of Smith, and it must be remembered that he became acquainted with the former as a native of Britain but a short time before his death. A plant in Rudge's herbarium labelled "*C. fulva*, a *C. flava* distinctissima," and collected in Anglesea by Dawson Turner, who might have been supposed to have known Smith's species, is undoubtedly *C. distans*. Winch's specimens in the possession of the Linnean Society, as well as some others derived from the same source in Sowerby's herbarium, are mostly *C. Hornschuchiana*,‡ while of the Shropshire examples in the latter collection, from Sir James Smith himself, and stated by him on the ticket to differ "from *flava* abundantly, particularly

* The figure in 'English Botany' has usually been quoted with some degree of hesitation, and it is uncertain whether it was actually drawn from Shropshire specimens. It is worth remarking that the roughness of the beak of the perigynium which is so conspicuous in the original engraving, and of which Smith has noted on the drawing itself, "roughness right, very important," has been entirely omitted in the revised plate of Syme.

† Boott MS. in sched. "The specimens in his (Smith's) herbarium from Beattie, which he quotes under his *C. fulva*, have the orifice of the perigynium distinctly membranous."—Boott, 'Illustr. Carex,' pt. iv, p. 138.

‡ The same may be said of E. Forster's in hb. Brit. Mus.

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in the straight beak of the seed, longer female spike, and rougher stem," one is clearly genuine and well-developed *lepidocarpa*, with a divaricate bract, and a deflexed beak to the perigynium.

The same uncertainty will be found to prevail at the present day. On the Continent the name *fulva* has been used indifferently as a synonym for *C. Hornschuchiana*, which has certainly nothing in common with the original description of Goodenough, as well as for the *flava*-like plant which has been contrasted with it; the two standing generally as distinct species. Dr. Hooker places his *C. fulva* as a subspecies of *distans*, taking apparently the Smithian view; while Babington seems rather to have had an eye to the *flava* alliance. Both authors have reduced *C. Hornschuchiana* to varietal rank. Dr. Boswell has described *C. Hornschuchiana*, Tausch., under the name of *C. fulva*,* Goodenough, and quotes Koch † as an authority, although referring to Reichenbach's figure of "*fulva*," ‡ which was drawn from a specimen from Hoppe himself, and even to the 'English Botany' plate, which reappears with altered fruit in his own pages. For his var. *β*, which he distinguishes mainly by the longer pedicels, he gives a reference to Reichenbach, n. 621 (*C. Hornschuchiana* from Hoppe), but "had Smith not described it as a species" would "certainly not have noticed it even as a variety." § His third form will be mentioned hereafter. It is more difficult to come to any exact conclusion as to the opinion of Dr. Boott, whose description has apparently been drawn up with the object of reconciling the conflicting aspects of the subject, and whose beautiful illustrations were, I think, evidently selected with a view to the same end.‖ He describes a typical plant for which he quotes Goodenough and Smith; a sterile variety distinguished only by its abortive perigynium; ¶ and a third form, the *C. Hornschuchiana* of Hoppe.** He quotes the analyses of Smith, Hoppe, and Koch, and concludes that many of the characters are not to be depended upon.†† I cannot help

* "*C. fulva* of British authors is liable to be confounded, not only with *C. distans*, but also with small specimens of *C. binervis*."—Syme, 'Eng. Bot.,' vol. x, p. 154.

† 'Syn.,' 889. ‡ 'Icon,' vol. viii, No. 620.

§ Syme, 'English Botany,' vol. x, p. 153.

‖ The figures of *C. Hornschuchiana* ('Illust.' pt. 4, tab. 443) are not very characteristic of the general habit of that plant; one specimen has crowded spikelets as in some form of *C. flava*.

¶ "The distinction between them is the yellow ventricose perigynium with its abortive achenium in the var. *β*, as contradistinguished from the ultimately brown perigynium with its perfect achenium, in what I have considered the type" (*Ib.*, p. 137).

** A specimen in hb. Borrer, labelled, by Coleman, "*C. speirostachya* fide Boott, Woods, &c.," is *binervis*. It is mentioned in Coleman's correspondence as "a Carex which Dr. Boott pronounces to be *C. speirostachya* of Sm., a species he is somewhat inclined to join with *C. fulva*; to me it seems far nearer to *C. binervis*" (Coleman MSS. Corr., 1846). Another specimen in hb. Boott, labelled by Coleman "*C. speirostachya*," seems to be *distans*.

†† "Your *C. fulva* is admirably expressive of its (*fulva*) character, and at the first glance impressed me with a specific difference. But if you look at Koch's description you will see how verbally alike it and his *C. Hosteana* are, and how probable it is that intermediate forms would occur which would be difficult to

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thinking that the original difficulty as to the *C. fulva* of Good-enough and Smith is at the bottom of this confusion; and Smith's own specimens certainly contributed not a little to confirm any previous bias in this direction.

In these doubtful circumstances it seems better to drop altogether a name which was abandoned as a mistake by its original author and has now lost all fixedness of application.

III.—Carex xanthocarpa, Degl., in Lois. Gall., vol. ii, p. 299;* F. Schultz, in Flora, 1854, p. 471. *C. fulva*, Hoppe, in Flora, 1824, p. 593; Koch, Syn., p. 884; Boreau, Fl. du Cent., p. 676.

Our Hertfordshire examples exactly agree with those in Schultz's 'Herbarium Normale' (cent. 4, No. 378). There are specimens in hb. Boott which are "*admirably* expressive of the *fulva* character" (Boott MS.). Those from another locality in hb. Borrer have been marked by him as "very near to *C. flava*." The lower pedicel is often much shorter than in Degland's description. I have found it growing in much wetter places than the next. It is especially luxuriant near Sawbridgeworth, where it is accompanied by *C. lepidocarpa*.

IV.—Carex Hornschuchiana, Hoppe, in Flora, 1824, p. 599; Koch, Syn., p. 884; Boreau, Fl. du Cent., p. 677. *C. fulva*, F. Schultz, in Flora, 1854, p. 471; and Hb. Normale, cent. 4, No. 379! *C. speirostachya*, Sm., Eng. Fl., vol. iv, p. 98.

In drier situations than the preceding, and much more generally diffused throughout the county, as seems to be the case also in Cambridgeshire.

C. xanthocarpa† differs from *C. Hornschuchiana* in its denser growth and more tufted root-stock; in the more luxuriant herbage of a brighter and lighter green; in the roughness of the upper

name" (Boott, in letter to Coleman, 1846). If the verbal similarity of Koch's descriptions is to be taken as evidence of the identity of the plants described, this is not the only species to be erased from our flora. The specimen itself will be noticed under *C. xanthocarpa*.

* "C. radice subrepente tenaci, culmo pedali obtuse triquetro superne aspero canaliculato, foliis planis rigidulis, vagina truncata, spica mascula tereti utrinque acuta, fœmineis subternis ovatis, infima longius pedunculata vix dimidie vaginata basi interdum ramosa, bracteis foliaceis culmo longioribus ore oblique ligulatis, utriculis striatis flavescentibus rostro tenui bidentatis squamam trinervem cordato-lanceolatam superantibus, fructu turbinato-triquetro fusco.

"Radix subrepens fibris longis barbata. Culmus pedalis striatus obtuse triqueter superne scaber hinc canaliculatus. Folia plana rigidula acuta duas circiter lineas lata, vaginis truncatis. Spica mascula solitaria teres utrinque acuminata cinereo-flavescens, squamis obovatis obtusis margine superiore membranaceis. Spicæ fœmineæ plerumque binæ remotæ ovatæ, infima longius pedunculata haud infrequenter ramosa, suprema subsessili. Bracteæ foliaceæ culmum superantes. Vagina hiatu oblique ligulata. Utriculi oblongi striati, in rostrum exile hispidulum attenuati, obiter emarginati. Squamæ trinerves cordato lanceolatæ utriculo vix breviores. Fructus turbinato-triqueter fuscus."—'Flora Gall.,' vol. ii, p. 299 (ed. 2, 1828).

The Cyperaceæ in Loiseleur's Flora were described by J. V. Degland, Professor of Botany at Rennes.

† This description was drawn up before I had made myself acquainted with Hoppe's remarks in the 'Flora' for 1824, with which it will be found to coincide in several particulars.

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part of the stem, with the lowest bract considerably longer, and generally reaching the male spikelet; in the female spikelets being fewer, with glumes* of a lighter colour, and proportionally narrower and more inclined to be acute; in the spreading perigynia of a lighter and yellower tint with a rougher beak,† which is devoid of the scarious membrane at the orifice; and in the male spikelet being more slender and of a lighter colour, but, as observed by Hoppe, far more dense, so that the glumes are with difficulty separated. Its nearest ally seems to be *C. lepidocarpa*.‡

On the other hand, *C. Hornschuchiana* has a more branched root-stock and scattered mode of growth, with the herbage shorter, more scanty, and of a darker, duller green; the stem is smooth and wiry; the bracts shorter; the female spikelets darker, longer, and much more distant, with broader ovate glumes with a wide scarious margin; the perigynia are of a fuller green when young, and when mature have a conspicuous white membrane at the orifice; the glumes of the male spikelet are laxer; it has altogether much of the habit and general appearance of *C. distans*. It usually represents *C. fulva* in our herbaria.§

While *C. Hornschuchiana* has been almost universally recognised on the Continent as possessing undoubted claims to the rank of an independent series, there have been various opinions as to the exact grade and position of *C. xanthocarpa*. The names *fulvo-flava* and *flavo-Hornschuchiana* applied at different times by F. Schultz will speak for themselves.‖ By Godron¶ it was reckoned as a hybrid between *C. distans* and *C. Hornschuchiana*; and more recently M. Grenier in his 'Flore de la Chaine Jurassique,' while denying the possibility of its being a hybrid derived from *C. Hornschuchiana*, on account of its frequent occurrence in localities from which the supposed parent is entirely absent (an argument which applies with equal force in the case of the Hertfordshire plant), has reduced it to *C. flava* as a merely sterile variety, and has stated that on one occasion he found on the same spikelet every intermediate form of perigynium between that of the ordinary *flava* and that of the present plant. Should this prove to be universally the case, the opinion of M. Grenier would coincide in a remarkable manner with that of Goodenough. M. Duval, who claims to have observed the sterile forms of *C. Œderi*, *flava*, *distans*, and *Hornschuchiana*, attributed their occurrence to the effects of the late

* The difference of *shape* in the glumes is well shown in Reichenbach's figures ('Icon.,' vol. viii, No. 620, 621).

† The beak is more slender than that represented in 'English Botany,' 1295.

‡ Hoppe, however, considers that *C.* "*fulva*" and *flava* scarcely resemble each other except in the very long bracts which extend beyond the stalk. He may have had only the typical *flava* in view.

§ Schultz ('Flora,' 1854, p. 471) mentions that all his English specimens of *C. fulva* belonged to *Hornschuchiana*.

‖ Dr. Boswell considers his *C. fulva*, var. *sterilis*, "a very remarkable plant, of which" he "had seen no British specimens," to be a hybrid between *C. fulva* (*Hornschuchiana*) and *flava*. He refers it to the *C. fulva* of Koch = *C. xanthocarpa*, Degl.

¶ 'Thèse sur l'Hybridité,' p. 21.

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frosts of spring.* The explanation seems at present hardly sufficient to account for the evident differences between *C. xanthocarpa* and any form of *flava*. And against it we have the positive testimony of Degland himself, who has mentioned the fruit, and of Boreau, who asserts that his plant remains constant under cultivation. The evidence of Boott, who certainly included *C. xanthocarpa* under his typical *fulva*, and who has described and figured a fertile as well as sterile form, may be taken as lending additional weight in the same direction. It seems more probable that both species have sterile forms. I have not found fully-developed fruit in our Hertfordshire examples, but the perigynia, which in this respect agree precisely with those of M. Schultz's specimens, are considerably smaller and less inflated than those of *C. Hornschuchiana* (with mature fruit), and in this respect differ widely from those of M. Grenier's sterile plant, which are said to be "du double plus gros, plus enflés, et pour cela plus divergents" (Grenier, *loc. cit.*). It is questionable perhaps whether the slender "spindle" shape of the male spikelet, on which some stress is laid by Babington in his description of *C. fulva*, may not sometimes be owing to a parallel affection of the masculine element.

V.—Carex distans, L.

Not uncommon on the wet moorish ground at the foot of the chalk hills in the north of the county, extending from Ashwell on the borders of Cambridgeshire to Wilstone on the very verge of Bucks. It occurs in several localities about Hitchin, and accompanies *Œnanthe Lachenalii* and *Samolus Valerandi*, both plants of a semi-maritime character, in each of their recorded stations. The correctness of the name has been questioned, as in the case of other inland counties, but the continental distribution is not against its occurrence in such situations, and it has been confirmed by high authorities. After the examination of a considerable number of specimens I can see no reason to doubt the accuracy of their conclusion. The *Carex* in the Kew herbarium from the neighbourhood of Barton, Bedfordshire,† distributed as *C. fulvà*, var. *speirostachya*, and which was collected at Shardeloes by Mr. Isaac Brown, must be referred also to the present species.

VI.—Carex binervis, Sm.

The true plant! but quite confined to the south of the county, where in shaded places it attains very large dimensions.

VII.—Carex lævigata, Sm.

This is given for Hertfordshire in the appendix to the 'Flora of Middlesex,' but I have never been able to trace on what authority. I need not add that I should be very pleased to be able to include it in our list.

* Gren., 'Flore Jurass.,' pt. 2, p. 857.
† See 'Journ. Bot.,' N.S. vol. v, p. 26.

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XV.

ANNIVERSARY ADDRESS.

By the PRESIDENT, Professor JOHN ATTFIELD, F.R.S., ETC.

Delivered at the Annual Meeting, 15th February, 1887, at Watford.

LADIES AND GENTLEMEN,—

A Natural History Society has few higher functions than that of disseminating knowledge of the laws of nature. And of all the relationships of natural law, whether as regards the universe, the world, or mankind, few can have more widespread interest for man than those which conduce to his own welfare. That welfare may be regarded from personal points of view, as the religious and the hygienic, or from the general standpoints of politics and of society. Last year your President had the honour of addressing you on the laws of nature generally—the laws themselves—and some of their relations to religion; he now ventures to treat of their relation to health. He ventures to consider, for an hour, the broad natural principles that govern health; and to consider principles only, for the details would occupy many Addresses.

THE LAWS OF NATURE IN RELATION TO HEALTH.

INTRODUCTION.

Perfect health. Picture such health. The health of, say, full-grown youth under the most free and favourable conditions. Perfect physical health; attended by perfect purity of mind and perfect strength of brain, associated with perfect development and cultivation of all the powers, and accompanied by freedom from all care and anxiety. Further, picture this health as commencing in the cradle, increasing in fulness towards manhood and womanhood, and extending to the age of a hundred or a hundred and four or five years, death then being only as the unawakening from sleep. That is perfect health.

Health more or less perfect, regulated by perfect natural laws. Endeavour for a moment to realise the general character of the more prominent of these laws. The comprehensive, far-reaching, all-pervading laws under which is supplied to us the light to which we wake in the morning and the warmth without which we should never wake; the laws governing the poise and motion of the earth, the moon, the sun, and all the spheres of the universe, yet governing our position and our movements on the surface of one of the smaller planets at the bottom of a sea of air. Glance at the laws that

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influence our health through our comfort and our well-being, namely, laws which enable us to yoke the lightning to our wishes and so to transmit our messages in a moment to the uttermost parts of the world, or, again, laws which enable us so to harness the force of magnetism as to guide the mariner to his haven over the trackless ocean. Try to realise the broad character of the laws under which we obtain pure air, pure water, pure food, and all that charms the eye, the ear, and the other organs of sense; and the laws that point to the character of the best clothing for the individual, the best dwelling for the family, and the best relationship of one dwelling to another in a community. These are some of the perfect, all-powerful, irreversible laws of nature.

The manner in which and the extent to which health more or less perfect is governed by laws such as those just sketched is the subject of the present Address. No one is so healthy but might be more healthy, and no one is so unhealthy but might be less unhealthy, by a proper apprehension and application of the all-sufficient laws of nature.

In the consideration of this subject, no doubt personal health must occupy the first place; for the health of the aggregate in a house, a town, or a country, must chiefly depend on the personal health of each inhabitant. But a healthy individual, or a healthy family, or a healthy community, may be the cause, perhaps the innocent cause, of ill-health in another individual, or another family, or another community; as, for example, when one person unwittingly gives fever to another, or when one or more persons draw pure water from a stream, but omit precautions that provide for the stream passing on pure to their neighbours. Therefore any comprehensive view of the laws of nature in relation to health must include the laws specially affecting the health of small and large communities, as well as the laws affecting the health of the individuals composing those communities. We must have healthy homes and healthy towns, as well as healthy individual inhabitants, for otherwise those inhabitants will soon cease to be healthy.

Ill-health will, in this Address, only be considered incidentally; that is to say, will only be alluded to as resulting from our ignorance of, or our nonconformity with, the laws regulating health. Ill-health once produced must be treated under a special set of laws applied by experts who have special knowledge respecting those laws, namely, by medical practitioners—a noble band of men, whose practice everywhere and always is to endeavour with the utmost practicable speed to reinstate in health those from whom that inestimable blessing has been temporarily withdrawn.

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The maintenance of the physical health of the individual must of course largely be influenced, indirectly, by a healthily constituted, a well-stored, and a contented mind, and by a pure and lofty standard of morals; while the health of communities will largely be affected by the character of their æsthetical, social, and political surroundings. Here, as everywhere, laws more or less obvious and more or less obscure are at work. These cannot, now, even be glanced at. Only the laws directly controlling physical health can be discussed within the limits of the present Address.

Our subject therefore shapes itself somewhat as follows. Personal health directly depends on the food we eat, the fluids we drink, the air we breathe, the clothing we wear. The health both of the individual and the family or household directly depends on the character of the dwellings we occupy. The health of the individual, the family, and the community, directly depends on the relation of dwellings to one another in villages, towns, and cities. Under this division of the subject, the laws of nature in relation to health will now be considered.

THE FOOD WE EAT.

Food is only a means to an end. Perhaps the best word to express that end is *work*; but work done within us by, for instance, the heart, the lungs, or the matter of the brain, as well as externally by, for example, the hands, the feet, or the muscles of the back. Indeed, from the point of view of health, the work done by the various organs of the body in blood-circulating, breathing, and thinking, is of far higher importance than the work done in sewing, walking, or weight-carrying. The work of the heart or the lungs is, during life, regular, untiring, unceasing; the work of the hands or the feet, irregular, intermittent, limited. Nay the work of, say, the seamstress, the pedestrian, or the coalheaver, only represents spare power at disposal over and above the power needed to carry on that work within the frame which life imperatively demands. An engine must first move itself; its spare power does the outside work. Be the work internal or external, however, food is the means by which the work is accomplished. "If any man will not work neither let him eat," said Paul. A far higher authority, the inflexible command of a law of nature, uttered without the agency of any human mouthpiece, decides that "if any man will not eat neither shall he work." Food and work are an equation, the one is the equivalent of the other; here man's will is powerless, here he must bend to law.

Let us look into this matter of the correlation of food and work

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just a little farther. With the commencement of life we commence individual work; and the work of the infant heart, lungs, and muscles generally, as, for instance, in crying and screaming, involves an equivalent and prior assimilation of animal food. Thenceforward the infant must take enough food to enable it to perform such outside work as crawling on all fours, walking, grasping, clasping. Not until much later must it carry weights. The less constructive inside work the child or youth has to do as it advances in age, the more power will it have at disposal for other inside work, as, for example, the work of the brain during education; the more power, too, it will have at disposal for all outside work, whether at the workshop, the counter, or the tennis-lawn. Growth having ceased, a still larger proportion of brain and frame will be at the disposal of adults for work in the world outside themselves. In connection with the subject of the food we eat, nothing is more striking than this law of correlation between food and work.

The law of the dependency of growth on food is only less striking than that just mentioned, because more familiar to us. So familiar, in fact, is this dependency of growth on the supply of food, from infancy to maturity, from birth to about twenty or twenty-one years of age, and so self-evident, that little need be urged in support of the law here, or of the inflexibility of the law. The child must absorb such mineral food as will provide for the growth of bone, such nutritious food as will provide for the growth of flesh, and such fuel-like food as will enable it to maintain the warmth of its daily increasing bulk. Something, however, must be stated respecting the kind of food necessary for the purpose, and on the quantity; stated at once concerning bone-forming food, and afterwards as regards flesh-forming and warmth-giving foods. Bone must grow by additions of bone-material, both animal and mineral, and that material must be supplied in the food swallowed—must be, for this is no matter of opinion, it is a matter of law. But if not supplied; what then? If the mineral material is, say accidentally or ignorantly, withheld; what then? The child will have, one cannot say bones, but bone-shaped things made of the flexible animal material, a material resembling gelatine, but it will not have true bones. These bone-shaped things, looking like real bones, but lacking the firmness communicated by the mineral material, will give way under the weight of the body; the child will be rickety. The child will have the "rickets"; a word equally expressive whether derived from the Greek or the Saxon; for if Greek it has

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reference to the result as a disease of the rhachis or spine, and if Saxon it has reference to the appearance of the child as resembling a heap or hump or rick, a small hayrick.

Here fond mothers will ask, "How can we avoid so dreadful a disease, how can we know which foods contain, or do not contain, this mineral material?" The full answer to that question would involve divergence into a lecture on certain chemical portions of physiology, which would be out of place. A short answer would be, "Avoid such mere starchy foods as arrowroot, and use such bone-forming flours as that of wheat." But that is an insufficient answer. Better fall back on a principle, and reply, "First recognise and become familiar with the law; then trust to your love and your intelligence to find the right mode of applying the law." Let us all do what we can, by example and by precept, to aid the future parents of unborn generations to know more about themselves and more about the laws which govern the health of themselves and their descendants. If we read only good novels and read only what is worth reading in newspapers, we shall have time not only to study but to become familiar with subjects more fascinating than those of fiction and infinitely more useful and elevating. If people spent less time in gossip about persons, they would have abundance of time for converse about things.

But, continuing the subject of the food we eat, we must pass from the relation of food and work, and the relation of food and growth, to the relation of supply and waste. And first as regards bone; respecting which, after what has been stated in connection with growth, very few additional words will be necessary. Growth having ceased, when our first score of years has passed, only the daily waste of bone has to be made good. This is accomplished by daily eating a commensurately small quantity of bone-material, contained so abundantly in many kinds of foods that we need take no thought of the matter so far as regards preservation of health. The point now insisted on is that here, as always, man is the creature of law; to the extent to which bone is worn away by the daily work of life, to exactly that extent is the waste made good by fresh supplies of bone-material in the food.

All that has been stated respecting the correlation of waste and supply of bone-material is true of the waste and supply of muscle-material or flesh. The ceaseless alternation of contraction and expansion of heart or lungs, or any lifting with the arms or walking with the legs, or any work whatever, involves an exactly commensurate expenditure or waste of muscle-material, or of muscle-forming food, and this expenditure or waste must be

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made good by an income or supply of an equivalent amount of that material. How can we best live in accordance with this law of health? Here it is difficult to avoid being technical. Shortly we may say that muscle-material is found both in animal food and in vegetable food; mixed, however, with so many other substances that we cannot easily make its acquaintance in a separate or isolated form. But there is one familiar variety of it occurring in what is called the white of egg, or, more exactly, albumen; and hence all the varieties of it are termed albumen-like or albumenoid constituents of food. Well, albumenoid substances are met with in most vegetable foods, and, generally in a more concentrated condition, in all animal foods. They are contained, for example, in a steak or chop, or in bread or potatoes. If, however, we have to perform a given amount of work, and must do it on a diet of beef or mutton on the one hand, or on a diet of bread or potatoes on the other, rest assured we shall have to eat more of the vegetable than of the animal food: the rules of arithmetic come in here as well as the direct laws of nature. But while there is no vast difference between vegetable food and animal food, science—which is a name for so much of nature's laws as is at present known—has nothing to say in favour either of an exclusively animal diet or of an exclusively vegetable diet. Men of science, perhaps in all blindness, cannot perceive that far distant time when animals shall no longer eat animals; when even dogs shall have ceased to love a bone, having become quite altered in nature—

> "With longer alimentary canals
> Suited to diet vegetarian."

The scientific hygieist fails to picture the period when our successors are to look back to the present flesh-eating days with incredulity; a period when our descendants' imaginations—

> "Aiming at fiction called historical,
> Will vainly try to reconstruct the times
> When it was men's preposterous delight
> To sit astride live horses which consumed
> Materials for incalculable cakes."

Before leaving the illustration of health-law afforded by correlative waste and supply of this muscle-material or flesh-material, a word must be said respecting, not the quantity, but the quality of the muscle-material supplied to the human system. So far as mere percentage of flesh-forming material is concerned, few articles of animal food excel the common vegetable seeds known as horse-beans. But man cannot digest the horse-bean; a fact which serves to show that to maintain health we must not only select

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food of the right chemical quality, but also of appropriate physical condition. The chemical usefulness of muscle-making food as coarse as that just mentioned is not lost to us. We give it to lower animals, and they convert it into what for us is more or less tender assimilable meat. As to variation in the power of assimilating food possessed by different individuals, that is a matter of ill-health rather than of health, and therefore is outside the scope of the present subject. Defective assimilation must be treated by the expert in matters of ill-health, that is to say, by the practitioner of medicine. Only when assimilation is satisfactory will "good digestion wait on appetite, and health on both."

From the laws governing the frame's income and expenditure of bone-making substances and flesh-forming materials, we pass to the laws illustrated by the last of the three great classes of food, namely, warmth-giving aliments. Most of each loaf we eat; the greater part of potatoes; a large proportion of farinaceous puddings, pie-crust, and cakes; sugar; butter and the fat of meat: all these are useless for bone-making and more or less useless for flesh-forming. Their chief office is, apparently, to burn within us night and day; thus maintaining that warmth of the body without which we could not exist for a moment. Not more certainly does fat or oil burn in a firegrate or lamp and give heat than it burns in the human body and gives heat. Further, a given quantity of fat or oil, when fully burnt, affords a given quantity of heat, and always the same quantity of heat, whether the fat be burnt in a stove, a lamp, or the human body. If we burn an ounce of butter in an appropriate vessel, in the ordinary way, the whole of the heat is evolved in a short space of time, and gives so intense a temperature that we speak of it as raising a thermometer to perhaps a thousand degrees. If we gradually eat an ounce of butter in the ordinary way and thus burn it in the body, we get the same total amount of heat from it as before, but that heat is evolved in a far longer space of time, and maintains the body during the whole of that time at about 98 degrees—the average temperature of the body. Not only does fat thus burn in the body, but all the other substances just mentioned similarly burn, maintaining the whole system at about 98° F. Some of the farinaceous foods mentioned may be converted in the body into fat, and this fat may be stored within us, occasionally to an inconvenient extent, but it is only stored and will certainly during life sooner or later be burned. It is only right to add that in place of so much heat some other force may be yielded by fuel-like foods—force directly enabling the system to perform a certain proportion of its work.

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To sum up respecting the food we eat. A healthy man—taken as the type of all men, all women, all children—may be regarded morally, mentally, physically. His moral and mental health are not now being considered, only his physical health, and, indeed, only his physical health in relation to the laws of nature—especially, just now, the laws of nature which govern the food he eats. Viewed thus physically, man is, like an engine, no doubt a wonderful structure; but, secondly, he is, like an engine, a structure destined to do wonderful work by the aid of what is daily supplied from without. If he is to grow healthily, and to maintain his grown structure in health, he must perfectly assimilate perfect materials, that is, food that will yield him bone, flesh, and warmth. If he is to do sound work internally for himself, and externally for himself and for others, he must be fed with materials that are convertible into such work, materials which are force-holding and force-yielding. Must be, not may be; for he is an absorbing and a radiating focus of irrevocable, irreversible, unchangeable, all-perfect laws. To the extent to which men and women, and young men and maidens, realise the existence of, and can place themselves in harmony with, these laws—eating neither too much nor too little of appropriate, well-selected, and, if cooked, properly cooked and tastefully served food, and avoiding rich luxurious living—to that extent will they have perfect physical health, so far as health is dependent on food. The farther we recede from savagery and advance in civilisation, the less can we trust to instinct and the more to knowledge respecting the kind and the amount of food appropriate for healthy life.

THE FLUIDS WE DRINK.

Very large proportions of our flesh and certain proportions even of our bones consist of water; about one hundred pounds of water being thus included within, and forming an integral part of, the flesh and bones of an adult of the average weight of one hundred and forty pounds. In breathing out the air from our lungs it carries off some of this water, which is, in fact, visible on a cold day as a little cloud in front of our mouths. The water thus breathed out every moment of our lives, awake or asleep, must be replaced by water, drunk with our food or at other times. For every half pint of water thus lost, half a pint of water must be drunk; because the average proportion of water in the body must, for various chemical and mechanical reasons, be maintained. Once more, be it observed, the case is one of must be, not may be;

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for it is a case of unalterable law. "But," say a few, "we never drink water, we always drink beer;" some others remark, "We rarely drink water, we generally drink tea or coffee;" while a child might say, "I drink quite as much milk as water." Forgive me, my friends, for seeming to contradict you, but you one and all probably drink quite as much water as those who drink little but water. Of 100 quarts of milk about 87 quarts are water; of 100 pints of beer nearly 90 are water; of 100 cupfuls of that favourite beverage you pour out of the teapot at least 99 cupfuls are water. Of 100 bottlefuls of claret, hock, or champagne, between 80 and 90 are water; of 100 bottlefuls of port or sherry wine quite 75 are water. Of those tumblerfuls of "grog" in which some people occasionally indulge—even if the gin, rum, brandy, or whisky be strong, and the proportion of "spirit" and water be half and half—three quarters of the tumblerful will be water; for the strongest spirits are usually half alcohol half water. When a man swallows a glass of "neat" spirit, therefore, he is really taking alcohol diluted with water. It is a question whether any man could have much undiluted alcohol in his stomach and live. Even the glass of ardent spirit is diluted as soon as swallowed by the fluids then within, or immediately afterwards within, the stomach. It is a question, indeed, whether a man could live long if he took water in no other form than that of port, sherry, or strong grog; that is to say, no tea, no coffee, no milk. Nay, the demand of the system for water probably could not be supplied if the only drink were the weaker wines. (It is to be remembered, also, that all solid food contains water—ordinary meat, poultry, and potatoes, 75 per cent.; many vegetables, 80 or 90 per cent.; bread, 40 per cent.) To maintain healthy bodies in their normal condition, and to enable them to do their life-work, they *must* have water. And they *must* have a full proportion of water, no matter what the idiosyncrasy of the individual. If they do not get it they become unhealthy, or die outright.

Doubtless the fluids we drink are important from other points of view than that of their water. The 13 per cent. of solids in milk consist of valuable bone-making, flesh-forming, and warmth-giving materials. Beer, wine, tea, coffee, etc., also contain small quantities of useful dissolved solids. But these solids are to be regarded as a part of the food we eat. So that the interest of the fluids we drink, considered as fluids, derives that interest almost solely from the water they contain.

From the standpoint of nature, some little interest—and from the standpoint of man, a great deal of interest—attaches to the use of

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stimulants in the fluids we drink; for it would seem to be not more instinctive to man to cook his food than to discover in nature, or by more or less of art to manufacture, substances which are almost purely stimulating principles. The instinct of man, in his uncultured and uncivilised state, and in widely separated countries, has led him to discover just those four or five plants, which, even now so far as we know, are the only plants that, like the tea-plant, contain one and the same stimulant. Nearly everywhere, also, man's needs seem to have led him to the process—a perfectly natural process, by the way; an accompaniment of the growth of the yeast-plant—by which sugar is converted into the stimulant termed *alcohol*. What is the use of such stimulants? Taken *in excess* they are poisons more or less insidious and harmful. The *theine* of tea, coffee, maté, and guarana, is least liable to be taken in excess, and is least harmful. Alcohol is most likely to be taken in excess, and is, therefore, most harmful; or, in the epigrammatic words attributed to the Scythian prince Anarcharsis, "The first draught serveth for health; the second for pleasure; the third for shame; and the fourth for madness." If mankind, especially in civilised countries, would consent to live at a slower rate, the second draught would be unnecessary and probably even the first. But mankind cannot now thus live, apparently.

> "Man's life was spacious in the early world:
> It paused, like some slow ship with sail unfurled
> Waiting in seas by scarce a wavelet curled."

Now, with civilisation has come the stimulation of alcohol or theine. The first draught and the second are taken by most of the youth and nearly all of the adult of both sexes, either as theine or alcohol; while, as alcohol, the third and the fourth are taken by sadly too many. Children do not need, and, indeed, rarely take, either alcohol or theine, nor, for that matter, either pepper or mustard with their food. These things are mere stimulants. They are not used in the early life of the individual, they were not used in the early life of the race. But swallowed in proper and moderate quantities, at proper times, in these days of civilisation, what office do stimulants fulfil in the system? "It would seem," as stated elsewhere by the writer, "that they do the important work of aiding the system, whenever necessary, to digest and to store up food, and to utilise its existing stores of fat and of flesh. A stimulant does some such work as this whether it belong to the tea class, like the powerful coca; the alcoholic class, as, for example, brandy; or the clear soup class, as, for example, beef-tea. In other words, the purpose of stimulants is, apparently, to stimulate the system the

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better to live upon itself, and the better to replenish its store of life-sustaining, work-performing, flesh and blood. The imprisoned miner, having no food ordinarily so called, but having stores on his own frame, is able to exist for many days, if only, by a periodical sip of brandy, he can stimulate his organs to utilize those stores. Of course he daily gets thinner, the elements of his thus-used flesh passing away as gases and vapours from his lungs and skin. The Indian performs a journey of two or three days on foot without any so-called food; but he really lives and works on the flesh stored in his frame, and lives satisfactorily if only he can chew his coca leaves, and so obtain the stimulus that shall induce his flesh to yield so much extra force. Of course he, too, daily decreases in weight, and must afterwards renew his jaded body by rest and nourishing food. The invalid, unable to take solid food, can generally take stimulating beef-tea, and thus stimulate his own flesh to maintain his life until he again is able to take true nourishment. That he loses flesh in the process is generally too apparent. These are extreme cases of what appears to be the ordinary action of stimulants when taken in proper quantities."

Even without the aid of stimulants all persons can fast, that is, live on their own flesh, for a certain length of time, without much risk of life, although with more or less of suffering. And with commensurate risk they may thus survive—one hesitates to say live—for a longer period, especially if stimulants are taken, and, of course, water. The greater the store of flesh and fat the victim has to begin with; secondly, the greater his powers of slowly but continuously subsisting on—we cannot quite say eating—that store; thirdly, the stronger his power of endurance; and, fourthly, the less external work he has to do: we say the greater his advantages in all these respects the longer will he be able to fast. If the victim is a willing victim—one of the so-called fasting men or women—he or she, so far as nature's laws are concerned, merely illustrates nature's power of working in an unusual direction when nature is foolishly prevented from working in the usual direction. So far as the person himself or herself is concerned, and all who aid or abet, an exhibition of this kind is senseless, contemptible, and degrading.

To sum up respecting the fluids we drink. While a few of them, as milk, contain true food, and while some of them, as beer, tea, and wine, contain a stimulant, they all consist chiefly of water, and their power of quenching thirst resides solely in their water. The water in these fluids, and the water we drink as water, performs the two important functions of (*a*) by virtue of its solvent

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powers, conveying the food we eat to every part of the frame; and (*b*) by virtue of its fluidity, maintaining the otherwise solid and rigid tissues of our system in that elastic and pliable condition essential to life and to activity. Nature demands that water, and water alone, shall fulfil these functions; the fulfilment being governed by exact chemical and physical laws.

THE AIR WE BREATHE.

A whole series of beautiful natural laws, those which we term chemical and physical laws, regulate the composition of the air we breathe, and regulate its temperature, pressure, purity, and its other properties on which, in a greater or less degree, the maintenance of health depends. The burning within us of the fuel-like portion of our food, already mentioned as maintaining our warmth, is accomplished by the air inspired by our lungs under laws more especially studied by the chemist. The poisonous product of that combustion, expired from the lungs, passes away into the air from the region of the mouth and nostrils, under the laws, chiefly of heat and of diffusion, more especially studied by the physicist—as explained in the previous anniversary address. Again, between the pure air and food we take in on the one hand, and the used-up air and other products we give out on the other hand, there are formed within us numbers of compounds under laws more especially studied by the physiologist. The meteorologist takes note of the effects of those physical laws which govern the pressure, temperature, and moisture of the air; effects which so much influence the comfort and the health generally of man. The study of each and all of these laws relating to the air we breathe is of unbounded interest, and would afford pure and unending pleasure to any student; but especially would the study charm and delight the student investigating them for purposes of mental recreation. At the same time, the breathing of air is so much less under our control than the eating of food or the drinking of fluids, that the majority of persons cannot be expected to find that interest in the study which it is capable of yielding. We are connoisseurs in the matter of eating and drinking, or we think we are; while we take the air pretty much as it comes, having in fact no choice in the matter. We do something in cold weather towards warming and a little towards changing the air of inhabited rooms, subjects that will be noticed in connection with that of the dwellings we occupy; and the inhabitants of large towns have done something, though not so much as might be done, towards diminishing the volumes of grosser impurities discharged into the air from chimneys,

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impurities which convert a cheerless enough cloud on the ground into a choking and blinding fog. Beyond this man feels so powerless over the air he breathes, that for the most part he treats its rich materials for thought with a shrug or at least in a *non possumus* spirit. Added to all this, varying conditions of the atmosphere do unquestionably produce effects on health that at present we cannot explain; effects that are scarcely referable to dryness or moisture, coldness or warmth, greater or less volume, or other known conditions. There is still much in connection with the air we breathe that is mysterious. It may however be worthy of notice that the scientific chemist has long suspected that some of the effects of vitiated air, and certain effects of normal air, are due to organic matter rather than to alterations in the proportions of natural constituents, a suspicion confirmed recently by the microbiologist, who, while finding abundance of those minute forms of life termed microbes in the atmosphere of cities and the air of a sick room, finds fewer in the air of the plains and scarcely any in the air of mountains a few thousands of feet high. What may be the exact connection between the presence of aërial microbes and the health or ill-health of man remains to be discovered—a discovery, we may add, that will certainly, sooner or later, be made: for it would seem as if all such so-called secrets of nature were merely truths veiled by the haze of our own imperfect understandings; such a haze as always disappears before the earnest, patient, untiring, humble, skilful seeker after truth.

THE CLOTHING WE WEAR.

From the extremes of heat and cold, even the healthy frame needs the protection of clothes. Now, natural law requires that these fabrics be bad conductors of heat; garments that in summer shall allow the minimum of the sun's heat to pass through to the already over-warm body, and in winter shall allow the minimum of the warmth of the body to escape to the outer cold air. Oddly enough, the best non-conductor is air itself; but it must be non-moving, or very slowly moving, air; so that if we can manage to enclose a sheet of air between appropriate sheaths, or imprison it in an appropriate net, we shall have a typical garment both for summer and winter wear. Such a garment is found in the woollen clothes or flannel of the cricketer's summer suit, and the woollen dress or overcoat of winter. A blanket is a similar covering, of world-wide appreciation, against the escape of warmth from the body during a cold night. An eider-down quilt is a similar air-enclosing shield of wonderful lightness. These fabrics are

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those which best enclose a layer of air, and it is this layer of entangled and scarcely moving air which gives to them their usefulness. It is the air within the blanket or cloth of wool, not the wool itself, which arrests the passage of heat. So it is with cotton or with linen. Place the hand on a layer of unspun cotton, commonly termed cotton-wool. The feeling is that of warmth. Spin the stuff into a thread and weave the thread into sheeting and place the hand on the sheeting. The feeling is that of coldness. Obviously there has been no change in the material itself, therefore it is the change in the condition of the material that has resulted in the change of effect from warmth to coldness. Either cotton itself or linen itself, that is, flax, is not by any means a bad conductor of heat; a sheet of cotton or of linen feels cold enough to the hand or foot; in other words it rapidly conducts heat away from the skin. Bring that same cotton or that same flax in the unspun or woolly condition against the skin and it feels warm. The fact is that, in the latter cases, very little of the layer of actual cotton or of flax, but a great deal of the entangled layer of air, is brought against the skin; and the layer of air, being a good non-conductor of heat, takes so little heat away that relatively we regard the materials as being warm. Wool or similar hairs of various kinds, silk, flax, cotton, are all useful as materials for clothes, the porous condition of the material rather than the material itself being the main consideration. Even skin, whether thick for foot-covering in the form of boots, or thin for hand-covering in the form of gloves, has its value for health purposes; but any extended use of such a slightly porous material as skin is inconsistent with the laws of health. The non-porous india-rubber waterproof clothing must only be worn when one desires to avoid the lesser of two evils, namely, the lesser disadvantage of over-action of the pores of the skin as against the greater dangers attending the wearing of wet clothes. These "waterproofs" must be taken off at the earliest possible moment.

The laws of heat govern the effect of the colours or pigments with which clothing is dyed as well as the effect of the material itself. A given fabric will reflect more heat if it is white than if it is black, and, generally, will have a somewhat varying power as a conductor or as a non-conductor of heat according to its colour. This influence of colour is of course greater in fabrics that enclose but little air than in those which enclose much air. The material of which a given pigment or dye is formed has some influence; different black dyes, for example, differing in their power of absorbing heat.

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Chemical and physical science, speaking by the mouth of the goddess Hygieia, has little more to say respecting the laws which govern the clothing we wear. The voice of the goddess of ornamentation is much louder; while the lungs of the votaries of fashion, in one century of one sex, in another of the other sex, drown the voices of many goddesses and ever produce a veritable Babel.

OTHER CONTRIBUTORIES TO HEALTH.

No allusion has been made to personal cleanliness; nor to that change of employment termed recreation; nor to physical exercise; nor to rest. For in these four matters, not only is there a fairly extended recognition of the fact that the laws of nature governing them cannot be disregarded with impunity, but there also does exist amongst people generally such a fair amount of knowledge on these subjects that it is now unnecessary to do more than mention them. Whether health will be best promoted, at any given time, by attention to cleanliness, recreation, more serious physical exercise, relaxation, or rest, must be left to the individual judgment. All are alluded to in the following pretty epigram from the Latin, "On a Natural Grotto near a Deep Stream":—

> "Health, rose-lipp'd cherub, haunts this spot,
> She slumbers oft in yonder nook:
> If in the shade you find her not,
> Plunge—and you'll find her in the brook."

THE DWELLINGS WE OCCUPY.

Into the question of healthy houses, regarded merely as dwellings, questions relating either to food or to clothes scarcely enter. Not so the question of water-supply, which is almost inseparable from that of the dwelling. Indeed, a full supply of pure water, a proper supply of pure air, and neither excess nor deficiency of warmth, are the chief desiderata as regards healthy habitations.

Man almost necessarily dwells only where nature supplies animal and vegetable life with a fairly regular supply of water. Under the laws of heat water is drawn up into the atmosphere as a pure invisible vapour from the more or less pure stores on land or the more or less saline stores of the seas. That vapour condenses to visible cloud in the atmosphere, whence, under the laws of gravitation, it again is drawn to the earth. From the earth over which the fallen rain flows, it dissolves, under chemico-physical laws, certain mineral substances which do not injure and perhaps promote the health of persons drinking the water. From the earth also, especially from its cultivated portions, the water dissolves, again

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under chemico-physical laws, certain products of animal and vegetable decay which, doubtless, are or may be harmful to persons drinking the water. No sooner, however, are these impurities dissolved, than nature, under chemical laws, begins to burn them up by the air dissolved in the water; and before the water has flowed far over or into the ground, it again has become hygienically pure, that is to say, entirely free from anything injurious to health. The slightest recognition by man of the working of the laws just mentioned would prevent him adding animal or vegetable impurities to water at the very moment of all others when nature has brought pure water to the actual dwelling he occupies. But, alas! man is ignorant of such laws, and ignorant is he likely to remain until some of his teachers, under an enlightened view of nature's laws and their origin, weekly preach those laws into his ears. A comparatively few yards of porous soil free from actual clefts will convert into hygienically pure water all the impurities cast out of a dwelling-house. There is not the slightest reason, except what is born of excusable—at present excusable—ignorance, or inexcusable carelessness, why the well-water of more or less isolated rural or suburban dwellings should be contaminated by household drainage or by any similar collections of impurities. Such refuse should be distributed properly instead of improperly in the adjacent ground, and then there would be no risk of the well being contaminated.

How to obtain a proper supply of fresh air to our dwellings, in quantity neither too large nor too small, and in temperature neither too high nor too low, is an extremely difficult question. This difficulty is not due to want of knowledge of the laws governing the matter. The laws of heat are ever at work, and also can be invoked artificially, to provide displacement of impure air by pure air, and the laws of diffusion of gases are ever at work providing for the removal of used-up or tainted air. The difficulty chiefly consists in our inability to apply our knowledge under ever-varying conditions. Take even the case of an isolated dwelling, standing within two or three acres or more of ground, where the external air is pure, and occupied and owned by a man who has the means and the will wherewith to obtain a proper supply of that fresh air for his household. The capacity of any given room does not vary; practically it always holds the same volume of air. But the persons who respire the air in that room may vary in number from two or three to twenty or thirty. The air in the room requires to be changed ten times as often for twenty or thirty as for two or three persons. What mechanical system of ventilation without

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draughts can be trusted to provide for such a state of things? Practically none. This difficulty is increased, obviously, by the facts that we can have little or no control over the temperatures of the external air that is to enter and displace that already within the room, and that those temperatures may vary greatly, especially in such a country as ours. The varying direction and varying force of the wind will also materially complicate the problem of satisfactory ventilation. All these difficulties are enhanced if the house is closely packed amongst others, or if the occupants are poor, or if the external air is liable to be impure.

Of course there is another side to the foregoing picture. An occupied house is always warmer inside than outside, hence the whole bulk of air it encloses is, under the laws of heat, ever rising up through and out of the house, especially from its upper parts, while a corresponding quantity of fresh air is ever entering the house, especially at the ground floor. Again, under the laws of diffusion, the moment the air of a room is rendered impure, and during the whole time that it continues impure, it and the external pure air commence and continue slowly to interchange with each other, through chimneys and open doors and windows, through chinks and cracks, and even through ceilings, walls, and floor. Again, the available amount of air in a room may be, and perhaps generally is, under ordinary conditions, much larger than the amount nature demands for the health of the few persons who habitually occupy the room. Again, most persons, even invalids, can bear a considerable change of the air near them, especially if the bulk of air moves, without catching cold. Again, the systems of fairly healthy persons can stand the inhalation of even highly impure air for the short periods of the various kinds of gatherings or meetings they may have occasion to attend, without any serious or prolonged harm to health. Lastly, when crowded rooms become unbearably close, yet must continue to be crowded for some time longer, and windows or doors or both consequently have to be opened wide, there are generally some persons who can bear without injury, or with only temporary inconvenience, the strong draught of inflowing air near such openings. With all these mitigations granted, however, there remains the fact that a certain amount of ventilation is essential to the occupants of all rooms; while it also is certain that the purchasable contrivances termed "ventilators" cannot be efficient ventilators under all the varying conditions mentioned.

What is the remedy against the imperfect ventilation of rooms? Fortunately experience teaches everybody something of the working

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of nature's laws respecting this matter. A person of even moderate intelligence can open a window or a door where a draught will injure no one. In an average household some of the members will have sufficient knowledge to enable them, at any considerable gathering of persons where perhaps also many air-consuming lights are burning, to distribute the air from open windows by aid of curtains so judiciously disposed as to allow of the entrance of the maximum amount of air with the minimum of draught. Perhaps the best form of ventilator is the old tube reintroduced by Tobin; a wooden or zinc tube a few inches broad, several inches wide, and about five feet long, placed in any more or less out-of-sight place in the room, the bottom end communicating with the external air by a similar, generally very short transverse tube carried through the wall. Such tubes may vary in size, or two or more may be used in large rooms. They really are inverted syphons, the slight warmth of the inside of the room above the outside enabling them, by well-known natural laws, continuously to carry inwards a current of air which quietly breaks in a fan-like manner into the upper part of the room above the heads of the occupants, a continuous change of air without a draught resulting. Window-sashes may be arranged on a similar principle but with less effect. According to the number of occupants of the room, each tube should, at its upper extremity, be closed, or partially closed, by a lid, or be left quite open. Even these tubes, therefore, need a little intelligent management. In short, the extent to which a room may be fairly successfully ventilated depends on the extent to which some one or more of its occupants realises and applies the natural principles involved. A proper supply of pure air to our dwellings can never be obtained merely by ventilators or other mechanical contrivances, it must always depend upon intelligence and knowledge.

The avoidance of extreme heat in summer and extreme cold in winter in our habitations is a matter of considerable importance as regards our comfort, and not inconsiderable as regards our health. Here experience guided by intelligence helps us much, while the natural laws which govern the matter are not at all obscure. A room which in summer has become pleasantly cool during a night may be kept cool until it is wanted, if blinds, curtains, and shutters are closed over the windows, and the door or doors not left open. For, convection of heat to the walls of the room by currents of hot air from without is thus avoided, diffusion between the hot air without and the cold air within is retarded, while any direct rays of heat from the sun are excluded. With a little light

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admitted, such a room may then be occupied by two or three persons, at all events by a few in relation to the size of the room, for several hours before the air inside becomes as warm as the air outside, or before ventilation is really needed. When either of the two latter conditions is nearly reached, doors and windows must be opened. For, the advantage of a lower temperature in the room having ceased, the next best condition of comfort is to provide if possible for a continuous movement of air, or gentle draught, "a lovely breeze," the moving air taking away moisture from the skin and producing a grateful sense of coolness.

The avoidance of extreme cold in rooms in winter depends, fortunately in some cases, unfortunately in others, almost solely on expense; for the laws of the matter are well known and their application quite easy. The burning of coals or other fuel in an open grate, as commonly practised in England, is doubtless absurdly extravagant when considered solely as a source of heat, more than three-fourths of the heat escaping up the chimney. Yet the chimney thus draws within itself a quantity of air over and above that needed for the combustion of the fuel, producing better ventilation of the apartment than would be obtained by less escape of heat up the chimney. Secondly, under such an arrangement gradations of warmth are obtained; for one may have general warmth by sitting at some distance from the fire, or may get a large amount of warmth in a short space of time and exactly at the moment one most wants warmth by standing for a minute or two quite near the fire. Thirdly, a bright open fire is a thing of beauty worth paying for. To warm the whole atmosphere of a house, or its chief sections, by heated pipes is more economical from the point of view of a mere warming arrangement, and, while less pleasant than an open fire to persons coming in from the cold external air and desiring to be quickly warmed, nevertheless gives a more general sense of comfort to those who remain for most of their time indoors. However, it is, again, a question whether one is not, on the whole, rendered more susceptible to cold when one leaves the house in winter if one has been living night and day in the temperate climate of pipe-warmed rooms and passages. The whole subject is obviously one rather for individual than general consideration; one to be decided by the conditions, occupations, and resources, of those dwelling in any given house.

THE TOWNS WE INHABIT.

The laws of nature affecting the health of the individual having

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been considered, and some further natural laws governing the health of households, especially in isolated habitations, having been set forth, there remain for treatment only the laws which operate in the special set of conditions produced by that close contiguity of dwellings characteristic of cities and towns.

The total amount of fluid and solid impurities of all kinds cast forth from the kitchens and other parts of more than a given number of houses per acre of ground—irrespective of dust-bin refuse which can be removed by cartage—quite overtasks the natural chemical purifying powers of that ground. Hence, in the first place, pure water cannot be obtained from wells sunk in such ground, and must therefore be brought to the town from some distant area by a system of open and closed mains and pipes. In the second place, especially with a somewhat larger number of houses, the total quantity of impurity cast forth becomes such a source of contamination, not only to the water of wells in the neighbourhood, but to the air, that it must be taken away from the town by a system of pipes, drains, etc., to some distant area. Here the laws of nature cannot be evaded; and their working is simple. A household must, in nearly every case, get its supply of water, say twenty or thirty gallons per head daily, from the earth, and when that water has done its duty of washing, cooking, etc., it must be returned to the earth. If the dwelling is isolated in an acre or so of porous ground, this intake of pure water and output of sullied water may go on within that area. If dwellings are crowded together, the intake of pure water must be from a distant area in one direction, and the output of sullied water must be to a distant area in another direction. But in both cases there must be ground whence to draw the clean water and ground on which to cast the dirty water. In both cases too we may trust to nature, and we may implicitly trust her, to convert the impure water into pure water ready again for the use of man. For, be it remembered, the stock of water in the world never varies. The water man has used before he will use again, and again, and again; each time perfectly purified in nature's perfectly appointed laboratory. It may be that a given country, in its wisdom, believing that it is choosing the lesser of two evils, elects to send more or less of its sullied water direct to its rivers and so into the sea. In that case the only variation in effects—in the intermediate effects—will be that the country will *pro tanto* lose the manurial value of that sullied water. Further, to the extent to which a country thus incurs an expenditure larger than its income, will it sooner or later become bankrupt. The result may not ensue for many generations, but

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come it must unless a true spirit of patriotism realises and avoids the evil. Be that as it may, the incidence of the laws of nature, fortunately, cannot be avoided. The sulliage of sullied water is sooner or later burnt out of the water by the burning power of the air always being absorbed by such water, or with which the water comes into contact during its flow towards the sea or in the sea itself. From the sea, as already stated, the water is lifted into the air as cloud, and is carried back by winds again to fall in full abundance at the very feet of man.

The gregarious tendencies of human beings not only involve difficulty as regards the getting of plenty of pure water and the getting rid of that water when sullied, but also as regards the getting of abundance of pure air and the getting rid of that air when sullied. And the larger the aggregation of people, the greater the difficulty. A human being in breathing renders a certain and rather large amount of air impure every moment of his life. Every scoopful of coal burned in a grate, every pound of burning candles, every pint of oil consumed in a lamp, every cubic foot of burning gas, renders impure a corresponding and very large amount of air. This impure air passes up and away into the atmosphere, sometimes under the laws of heat which harness and rein the wind, and always under the laws of diffusion. Fortunately the largest city is not yet so large as to interfere with impure air exhaled from throats and chimneys getting away sufficiently fast, and pure air taking its place sufficiently fast, to maintain millions of inhabitants in a fair state of health. The trouble rather is, at present, that owing to imperfections in the construction of fire-grates and furnaces, the gaseous product of the combustion of all fuel is accompanied by sooty, oily, and other fog-forming intermediate products. For this evil let us hope that art will sooner or later furnish a complete remedy. Nature furnishes the remedy against the accumulation of impure gas in the atmosphere generally; for the impurity which would be poison and death to the animal kingdom is food and life to the vegetable kingdom, and thus is the atmosphere kept always in a normal health-giving condition.

Another, and, as regards preservation of health from attack of infectious disease, more serious source of contamination of the air of towns, is to be found in the gratuitous delivery of foul vapours from certain of the gratings at our very feet as we walk along our streets and roads. Now this subject is in several senses unsavoury, but it is one that affects the health of ourselves and the health and perhaps lives of our children. Therefore no apology is offered for its introduction. Indeed it is time that the public,

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men and women too, should speak out strongly once for all on the matter. There is a general impression, and it is probably a right impression, that we have gone a little too far in the matter of sewer-ventilation—a little too far in a wrong direction. We are told, doubtless rightly told, that certain fevers which decimated the inhabitants of our towns up to a hundred or even fifty years ago, were probably largely due to the emanations from open urban ditches and similar collections of impurities. Well, we filled up the unsightly conduits, we avoided pestilential accumulations, and we substituted closed pipes and drains. But now, under some fancy that these tubular channels all need ventilating, we adopt such mechanical contrivances as shall, or, at all events, may and often do, bring the noisome vapour to the feet of adults or children at any moment as they walk past the gratings in the ground, or, much worse, bring it to the mouths and nostrils of girls and boys as they play near or perhaps actually peer into the grid-guarded caverns. True, we do not allow the contents of the passages to stagnate, as in old days, but so far as we ventilate them, that is, wash them out with air, and bring that possibly pestilential air to the lungs of human beings, to that extent we are making a retrograde movement towards the fever-breeding arrangements of pre-sanitary history. If our practice in this respect is right, we ought to increase the number of these gratings, or, indeed, have open ironwork along the whole length of these reeking aqueducts. If the practice is right, why not dry up, by the ventilating current of air, not a part only of the fluid, but the whole. But our practice, in my opinion, is not right. These mains do not need ventilation, or not as a rule. In our larger cities, wherever the horrid galleries are of a character to need workmen within them, ventilation is necessary for the sake of the men, lest they "be stifled in the vault to whose foul mouth no healthsome air breathes in." But such large mains generally run under wide roads whence the vapour can, through the gratings in the centre of the road, the more readily escape up into the atmosphere. At all events ventilation then offers the minimum of evil. But why drains into which a man never goes, which are in fact too small for a man to enter, should all be ventilated, is beyond my comprehension. Of course there must be no such pressure within them—caused by the rush of flushing-water or what not—as to drive their vapour-laden air past the water-traps of our homes into the rooms in which we live. But some judiciously disposed vent-pipes, such as are largely used already, opening above the ground level, but not near windows or other inlets of houses, will prevent that result. These

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vent-pipes (do not call them ventilating pipes, for there should be no such current of air through them as constitutes true ventilation) can be kept clear by a semi-annual inspection costing far less than the labour necessary for keeping clear the objectionable ground-level gratings. Some persons seem to be under the impression that poisonous gas is always generated in those sullied-water passages, and that this gas needs to be diluted with as much air as can possibly be drawn into and out of the loathsome watercourses. Now the contents of the courses, in any properly regulated district, are never allowed to stagnate long enough to produce gas; secondly, even the stagnant stuff rarely produces a paltry few bubbles of gas; thirdly, such gas is probably harmless. No, the exact constituent causing harmfulness is not known, but what carries or conveys that constituent is the vapour of the smelling stream. The stream will saturate the air in the drains with its vapour just as a perfume will saturate the air in a scent-bottle with its vapour. Ventilate the scent-bottle, that is, arrange for a current of air to pass through the bottle, and what will happen? Each fresh quantity of air will soon be saturated with the vapour of the perfume, and, as you drive out or draw out that quantity, fresh air will enter to be again saturated, and so on until you have dried out much of the perfume. Ventilate the polluted passages alluded to, and what happens? Each fresh quantity of air drawn in will soon be saturated with the vapour of the filthy fluids and moist solids, and, as you drive out or draw out that quantity, fresh air will enter to be again saturated, and so on until you have dried out much of the fluid. In fact, the process is not fair dilution or ventilation at all, it is one of slow evaporation; for nobody should dream of truly ventilating any apartment at the bottom of which vapour-yielding fluid is ever running, or on the floor or in the corners of which moist masses of microbe-yielding mud are ever resting. The removal of the vitiated air of such a room by inflowing pure air would immediately and necessarily be succeeded by the vitiation of the latter, and so on, and so on, night and day *ad nauseam*. That is a fair picture of what its advocates are pleased to term sewer-ventilation. It is not true ventilation at all; it is a slow, continuous but never complete, drying up of liquid and solid sewage, carried on in the midst of our homes, playgrounds, and promenades. There is no occasion to continue this loathsome, this repulsive vapour-carrying and perhaps fever-carrying process. There is not the slightest occasion to ventilate all these treacherous tunnels. Fortunately air is not often flowing at any important rate into or out of them, but that it is sometimes flowing out most persons who

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often pass the ground-level gratings can testify. To put the matter shortly and plainly. A sewer is like a scent-bottle, the longer you ventilate it, the longer it will smell—while any fluid remains. Don't you want it to smell? No! Then don't ventilate it. Do away with the ground-level gratings altogether, except where men work in the gross galleries below; never attempt to ventilate all these tubes of turbidity; only where pressure is liable to accumulate place vent-pipes whose external orifice shall be above the heads of the inhabitants of the town, and far from the windows of houses. If you *must* extract the vapour-laden air, burn it. But what is required, as a rule, is *vent, not ventilation.*

CONCLUSION.

In this Address an attempt has been made to direct attention to the laws of nature—those grand "records of all experience"—as they are related to health: as related in the personal matters of the food we eat, the fluids we drink, the air we breathe, and the clothes we wear; in the important matters of water-supply, ventilation, and due warmth in our dwellings; and in the matters of refuse-disposal and pure air-supply of our towns.

To the extent to which the individual acts in harmony with natural law, to that extent will he have health. To the extent to which a household acts in harmony with natural law, to that extent will a household have health. To the extent to which a local community acts in harmony with natural law, both by its units and by the members and officers of its Board of Health—some of whom must possess adequate chemical, physical, and biological, as well as general medical knowledge—to that extent will the town or city have health. To the extent to which a nation realises and places itself in harmony with the laws of nature that govern the health of its individuals, the health of its households, and the health of its communities, to that extent will the nation have national health, prosperity, and happiness, and to that extent will it contribute to the health, happiness, and prosperity of all nations and races which recognise the sway of natural law. Finally, to the extent to which a generation lives, moves, and has its being, less and less in accordance with the empiricism of past generations and more and more in accordance with the laws of nature, to that extent will the children of that generation, the parents of generations yet to be, become more and more healthy, and the sooner develop into all that man is destined to become.

"Yet I doubt not thro' the ages one increasing purpose runs,
And the thoughts of men are widen'd with the process of the suns."

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XVI.

THE HABITS AND ECONOMY OF OUR SOCIAL WASPS.

By F. Maule Campbell, F.L.S., F.Z.S., F.R.M.S.

Read at Hertford, 2nd December, 1886.

The relations of the wasps, social and solitary, are very interesting, for naturalists place them in the order Hymenoptera, together with the bees, ants, sawflies, and gallflies. This order is divided into two sections. The first consists of insects the females of which are furnished with saws, augers, or other boring instruments, with which they prepare holes to receive their eggs. The second section consists of insects the females of which are furnished with a venomous sting. But this section is a large one, and is subdivided again into two subsections, of which the bees form one. The other subsection comprises the predaceous stinging Hymenoptera, and includes the proverbially hard-working ants, the solitary wasps, and the social wasps. The technical character by which these two groups of wasps are distinguished is found chiefly in the tarsal claws, which are cleft in the solitary wasps, and single in the social, while the physiological differences are very obvious. The solitary wasps consist only of males and females, but the social wasps, like the social bees and ants, consist of males, females, and neuters. The solitary wasps, as the name implies, do not live in communities in which there are mutual obligations and responsibilities. The mother solitary wasp makes a nest in a cavity in sand, herbaceous plants, or trees, according to its species, and conveys there a store of insects and spiders—dead, or stung to torpidity. She concludes her maternal duties by enclosing a portion in each cell.

There are in the United Kingdom but seven kinds of social wasps or Vespidæ, including the hornet, which is one of our wasps. It will therefore be understood that when I speak of the habits and life-history of wasps, my observations apply also to hornets.

But before we go further it would be as well to touch upon the difference between wasps and bees. Bees procure their food from flowers, but wasps occasionally take sweets, although their chief food consists of insects. The flattened spreading form of the first tarsal joint of the hind-leg of a bee is, we all know, associated with its pollen-carrying habits, and this peculiarity in a greater or less degree is found in all bees. Even the parasitic bees, *i.e.* those which act the part of cuckoos in laying their eggs in the nests of their neighbours, are no exception; for, although their first hind tarsal joint is smaller than that of other bees, it is still broader than that of the predaceous wasps, which is cylindrical. There is a further distinction between bees and true wasps, for the fore-wings of the wasps when at rest are folded longitudinally, which is not the case with those of the bees.

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It is curious to find that communities of the wasps and humble-bees endure but a few months, while those of the honey-bees and some of the ants will, under favourable circumstances, last for many years. In the case of the honey-bee a swarm issues from the over-populated parent stock, composed of the queen, drones, and workers, to find fresh pastures, while a sufficient number of bees are left behind to assist the selected young queen in her maternal duties. But the wasps make no such migration. The males and the old queens and workers all die when the autumn frosts set in, while the young queens, which have yet to lay their eggs, hie away to find protection in some quiet nook, where they remain until the first bright days of spring. It is then that they sally forth in search of a suitable place to commence their nests, and frequently fall victims to some one who destroys them as depredators of fruit and progenitors of countless enemies of humanity.

Should any of my hearers ever be induced to commit such a regicide, or rather reginacide, I beg they will remember that the insect itself and its offspring, if allowed to survive, would remove from both field and garden incalculable numbers of small caterpillars and other larvæ which are so harmful to vegetation. It certainly seems strange that people should grudge the wasps their share of the fruit they help to preserve. The constant war waged against wasps and hornets may end in a plague of flies, just as the destruction of hawks has led to a superabundance of small birds.

But I am met with a reply to my plea for mercy that "wasps sting." Of course they do when interfered with, but how few persons are stung who leave them alone! They never use their sting unprovoked; they mind their own business, and can be watched and studied with greater safety than bees. There is but little danger of being pricked by a wasp hovering round the room, but if you provoke it to declare war there is no doubt about either its intentions or its success, so rapid are its movements. There are many so-called cures for stings, ranging from ipecacuanha to the blue bag, but, to use the words of the great Hunter, "I have heard of cures, but I never experienced one."

Let us return to one of our young queen wasps. We left her for a season stowed away in a corner. Occasionally she may have taken a flight in the milder days of winter, but it is in the early spring that she begins her serious duties of life, and sets to work house-hunting. Unlike the hive-queen, she is alone in the wide wide world, with no friend to help her. She has many enemies besides man, yet, unaided, she has to find and make her home and rear the first brood. Food is scarce, and the very sunshine which she needs for her own vitality is also required to provide her with prey. She is constantly exposed to the cold rains and late frosts which destroy so many of her sisters, and which this year had the effect of reducing the wasp population in the Home Counties in a very marked degree. We will, however, suppose that our young

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queen wasp of the species *Vespa vulgaris* has survived all these dangers, and that her wanderings and industrious examinations have led her to choose a hole in which she can begin her life's work. She has collected some wood-fibre from some old tree, and, having masticated it with her mandibles, and saturated it with her saliva, she lays the foundation-stone or rather paper of the nest from which, if all goes well, she will rear about 30,000 progeny. She attaches to the top of the hole a little strap, at the bottom of which she builds three or four hexagonal cells opening downwards, while above them is a little conical cap about an inch wide. In these cells she places her eggs, and she soon increases the number of cells as well as the size and thickness of the covering cap. The rising city is still dependent on the chances of a single life, for the founder has to feed the larvæ, and can receive no assistance until they are hatched. She takes care, however, at first only to rear neuters or workers.

And now let me draw your attention to a well-made large nest. The paper covering outside varies in colour and form with the species. The interior of the nest consists of six or seven or more horizontal layers of hexagonal cells, each layer sustaining the one below it by paper attachments like pillars, while all the cells open downwards. The nest was not always so large as it is now; little by little it has grown. When once surrounded by its paper covering it may be said to have been complete; but the city had to be increased with a view to its future population. The horizontal layers of concentric cells were made larger in circumference, fresh layers were added, the external limit was removed from the inside, while the material thus gained may have been re-manufactured, and again re-laid on the outside. Over and over again has the inside of the sphere been found too narrow for the energies of the inhabitants, and that which was approved of one day as adequate to their wants has been necessarily enlarged the next. The cavity in which the foundations of the city were laid has also constantly been found too small. Piece by piece the earth has been removed to permit of the enlargement of its borders, necessitating the removal of old attachments and the making of fresh ones to support the whole fabric.

As autumn approaches, the population consists of the mother queen, the workers, the males, and the young females. Everything seems to indicate peace and prosperity, until the queen ceases to lay eggs, or the cold nights set in. The queen then dies, the young females betake themselves to their winter lodgings, while the workers seize the larvæ and carry them beyond the walls of the city to die. It is then that the working wasps lapse back into the primeval stage of solitary vagabondism. They abandon their responsibilities and forsake their home, and lead the life of predatory tramps. Finally, benumbed with cold and with failing vitality, they cannot fly, and only crawl from place to place, frequently stinging the human hand which is accidentally placed on them. It is indeed in late autumn that a plea for mercy cannot

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be entertained for the working-wasps. They are "workers" but in name, and summary execution is the only sentence on creatures which are now useless and dangerous. As for the deserted city, the rain rots the paper walls, which soon become covered with fungoid growth, while the wood-lice are the only inhabitants of the ruins. Such is the history of the rise and fall of a wasp's nest, which in a few weeks has run its course.

I have already referred to the way in which the wasps manufacture the paper of which their nests are composed. They are frequently to be seen engrossed in gathering filaments from old timber or from vegetation, which they roll into a little pellet and carry between their mandibles to their nest. What follows is best described by Dr. Ormerod,* who noticed a wasp thus burdened "enter her nest for half a minute, when she emerged, mounted astride of one of the covering sheets. She pressed her pellet firmly down with her fore-legs till it adhered to the edge, and, walking backwards, continued this process of pressing and kneading till the pellet was used up, and her track was marked by a short dark cord lying along the thin edge to which she had fastened it. Then she ran forwards, and as she returned again backwards over the same ground, she drew the cord through her mandibles, repeating this process two or three times till it was flattened out into a little strip or ribbon of paper which only needed drying to be undistinguishable from the rest of the sheet to which it had been attached, and then she gravely retired into the nest again." Each wasp seems to work like a hive-bee on its own account, here, there, and everywhere, without any organization of labour. It is stated that only young wasps build, and this is supposed to be due to the glands which secrete their saliva being more active. The queen wasp also abandons her architectural operations as she advances in age, and confines herself to her maternal duties.

The horizontal layers of cells are not connected with the paper covering except at the top, but this is not always the case with the hornet's nest. The commencement of each layer of cells is made after the same fashion as that of the nest, by attaching to the centre of the lower layer a strap, at the end of which a few cells are first formed. The cells are increased in the same way as the outer wall, by the gradual laying on of material, which, however, is of a closer texture. I have already stated that the cells are hexagonal, but their base appears to have no geometrical form, and is very different from the beautiful inverted pyramid consisting of three rhombs, which constitutes the base of the cell of the hive-bee. The cells of the wasp may be described as commencing at the bottom with a small pouch which gradually expands into a hexagon. The increasing size of the cells prevents them from all being vertical, and in a large layer, the outside cells approach, though they do not reach, a horizontal position.

The nests of the different species of wasps, although of one type, vary in detail. They are all constructed of paper, yet each species

* 'British Social Wasps,' p. 193.

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does not show the same preference in collecting the raw material. The nests can, as regards the outer covering, be divided into two classes, the laminar and the cellular. The common wasp and the hornet adopt the cellular plan; that is to say, there are in the outer covering a number of cavities of the form of a closed tube running parallel to the axis of the next; while others, like *Vespa rufa*, affect the laminar construction, *i.e.* the outer covering consists of successive layers of paper laid close together and overlapping each other. The structure of the nests of the different species varies, within certain limits, with the position in which they are placed. The hornets make a less complete paper covering to their home, according as it is in a hollow of a tree, or in a roof, or under the ground, and the same may be said of all the wasps.

It is impossible to compare the nest of the wasp with that of the honey-bee without being struck with the differences that exist. The British wasps have no need of such a durable material as wax. Unlike some of their relations abroad they store no honey, if indeed anything, nor do the young larvæ float in a liquid, as is the case with the bee. Except the hybernating females, they live but in the season of plenty, and their paper nest is illustrative of their ephemeral life. What need have they of a lasting abode? It might indeed be expected that a nest made of paper would have some characteristics very distinctive from one made of wax, and that insects of different habits should prefer different architectural arrangements. But who would have thought there would be such dissimilarity? The waxen comb of the honey-bee is placed vertically with cells on each side opening horizontally, but the natural position of the paper comb of the wasp is horizontal, while the cells are only on the lower side, and open downwards. Yet I would suggest that the material of the wasp's nest may account for this peculiarity. Let us bear in mind that the paper is made by the mastication of vegetable fibres saturated with moisture from the mouth of the wasp, and that it is laid on wet. It is evident that if, as is the case, the nest were built from above downwards, the recently-added portions would not dampen the previous structure, for the moisture would pass downwards, as seen in a wet rag or piece of paper hung up to dry. The same principle more strongly affects the position of the cells. Time is not money in the development of a wasp's nest, but strength. If the community is to be flourishing, the population must be large. There must be no delay in breeding, and so the eggs must be placed in the cells as soon as they are half-built. But damp is an injury to wasps, and especially to the larvæ. Yet as the cells open downwards the heavy moist air caused by their recent construction can escape, and they thus dry quickly, as is the case with inverted wet bottles.

We have thus far traced the history and described the architecture of a wasp's nest, and we have now to follow the development from the egg to the perfect insect. The royal mother securely fastens each egg as it is laid to the side of the cell at an angle of about forty-five degrees. The egg is about the twenty-fourth of

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an inch in length, and so strong is its attachment that the larva when hatched can sway to and fro, shrink into a sphere, or extend itself to full length without leaving the cell, and without running any risk of falling. It now becomes dependent on the workers for its daily food, which is sometimes given in the form of small pieces of insects, and at others as a liquid regurgitated from the pouch of the nurse, just as the honey-bee deposits the honey it has collected. The larvæ have strong mandibles in all their stages, and it is a pretty sight to see them, when disturbed by some movement, stretch themselves out to their full length, and open and shut their mandibles with as much unmistakable expression of a desire for food as the fledglings in a bird's nest. They are easily fed. I was a foster-mother to about a hundred for nearly a fortnight this year, and the avidity with which they partook of all kinds of animal food showed the great quantity of insect-life required to support the inmates of a single wasp's nest. The larvæ remain attached by the tail to their egg-shell until after they have shed their first skin; and now commences the first important epoch of a wasp's life.

Let us bear in mind that a larva in this stage is hanging obliquely from a spot about half-way up its cell, which opens downwards, and before it turns into a cocoon it has to abandon its old anchorage and find another at the top of its cell. Many seem to fail in this attempt, and fall, when they are removed from the nest, possibly for the same reason that the sick and weakly babies are destroyed by some savage races.

But the question remains to be answered: How is it that any larvæ manage to perform unassisted this acrobatic feat? The larva has no legs, but it has strong mandibles; while at the end of the abdomen there is a surface on which are two protuberances. When these are withdrawn, the surface forms a sucker which can be released by their protrusion. It is possibly by the alternate attachment of the mandibles and the sucker to the different sides of the cell that the larva accomplishes its first journey, which would be after the manner of the now superseded sweep-boy up a chimney.

The larva having reached the top of its cell secures itself by its sucker, feeds, if possible, more voraciously, and commences to spin its cocoon, or the silken tube which is to protect it during its pupa stage. A delay in this work would be fatal to the perfect development of the insect, for the larva soon becomes so fat that it is impossible for it to turn and reach the bottom of its cell with its mouth, where the glands yielding the secretion which forms the threads are situated. The time now soon arrives when the larva entirely fills its cell, and begins to cover the opening with a silken texture. Unlike the larva of the bee, which is assisted by its elder sisters, who place on the top of the cells a thin wax covering, the wasp's larva, with a spirit of independence such as might be expected from the offspring of a predaceous insect, performs all the work of the cocoon by itself. Self-imprisoned, it casts its second skin, and in a little more than three

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weeks crawls out of its cradle, a pale but a perfect wasp, attaining its full colour in a few hours. In the cell it has just quitted there is to be found the history of its infant-life. There are seen the egg-shell, the first skin with the first pair of mandibles, the second skin with the second pair of mandibles, the remains of its pupal garment, and the undigested food. Even the cocoon lines the cell and can be removed with warm water, just as that of the honey-bee with an alkaline solution. The wasps clean the cell as well as they are able, and the queen deposits another egg, which in its turn passes through all the stages of wasp-life. The male and female cells are larger than the others.

The wasp is one of the most industrious of creatures. It rises earlier and goes to bed later than the bee. Sir John Lubbock, in his interesting book, 'Ants, Bees, and Wasps' (pp. 321 and 423), details how a wasp in August paid 116 visits in one day between 4·13 a.m. and 7·46 p.m., and carried off 64 grains of honey. He had accustomed three bees to go to the honey, and the first bee only arrived at 5·45 a.m., and the last bee at 7·15 p.m.

I fear that wasps are remembered by their vices rather than by their virtues. It may well be said that "the evil that wasps do lives after them," for like bees they are frequently unable to withdraw their sting from the wound it has caused, and they become so mutilated in obtaining their freedom that they die shortly afterwards. This however occurs more often with bees than with wasps, which seem to have a greater control over their sting. The poison of the wasp is different from that of the bee, if I may judge from its different effects. Like most bee-keepers I am proof against the poison of a bee's-sting and only feel the puncture, but the sting of the wasp causes a slight fester, a considerable swelling, and a great irritation which lasts several days.

All beekeepers recognize the buzz of the angry bee, and profit by the warning, but there is a silent rapidity in the movement of wasps when bent on mischief which prevents any attempt at avoiding an unpleasant contact. Much of their success in attacking other insects is due to the same settled purpose, and they are in the habit of working noiselessly. From a hive of bees may be distinguished the hum of content, the cry of passion, and the note of the queen; but from a wasp's nest proceeds no noise. All is still as death, and is in keeping with the predatory habits of the community.

The largest wasp's nest known is referred to by the Rev. J. G. Wood in 'Homes without Hands' (p. 237), and is to be seen in the Museum at Oxford. It is of the shape of a huge turnip, and nearly fills a glass case 2ft. in width and 4ft. in height. On the 18th July, 1857, it was taken as an ordinary nest in Cokethorpe Park, Oxfordshire, and was removed to a window of a dwelling-house, with its inmates, who were regularly fed on beer and sugar. The workers of two other wasp-communities, possibly owing to the loss of their queen, joined it in the month of August, and the usual daily allowance for the whole colony was a pound of

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sugar and a pint of beer. Under these advantages the nest was gradually increased to its gigantic size, until it succumbed to the cold and damp of late autumn.

Bee-keepers will naturally ask how it is that the death of a queen wasp should lead to the dissolution of its nest, for the loss of a queen bee is speedily repaired by the bees rearing in three weeks a royal insect from one of the many larvæ which with ordinary food would have become a worker. The explanation is that though in the wasp's nest there are many perfect females, living together in perfect concord, there is only one, and that is the queen, capable of laying eggs which produce the workers, upon whom the young are dependent for their food; the other females are her children, who do not commence laying until the following spring, unless hatched very early in the year, while the young queen bee commences her maternal duties about 46 hours after her nuptials. It is true that parthenogenesis sometimes occurs with the neuter wasps, as with the neuter bees, but the few offspring are likewise males. The loss of the royal mother-wasp is thus almost always irreparable. The bond of union of the community is broken, and the nest soon becomes forsaken.

Like other creatures, wasps have their illnesses apart from the effects of cold and wet. They suffer from internal parasites, while in tropical countries fungoid growths block their spiracles and air-passages. They have many enemies, and among them the ruby-tailed *Chrysis*, which rolls itself up into a sting-proof ball like a wood-louse and lays its eggs in the cells of the comb. Their homes also occasionally harbour unbidden guests, such as snails and beetles. Amongst the latter is a species, *Rhipiphorus paradoxus*, which is a remarkable insect, both on account of its habits and the development of the mouth-organs. It lays eggs in the cells of the wasp's nest, and the young larvæ feed on the wasp-grubs. I found several in the month of August this year in each nest I examined, and I suppose my good fortune was due to the scarcity of nests. The beetles had just arrived at the perfect form, and as I held the comb in my hand some were even struggling to release themselves from their cocoons, which were covered just in the same manner as those of the wasps. Rye* mentions that he has a specimen taken from under bark in Scotland, and that the beetle is found sometimes on flowers and on the sap of trees. It is evident that the perfect insect must hybernate, for the wasp's nest can offer no shelter in winter.

In conclusion, let me again remind you that the wasp is not a spiteful creature, and that, as we consider the labourer to be worthy of his hire, so we ought not to grudge the wasp a taste of our best peaches, when we know the good she confers upon us.

* 'British Beetles,' p. 168.

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XVII.

NOTES ON BIRDS OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1886.

By JOHN E. LITTLEBOY.

Read at Watford, 22nd March, 1887.

I HAVE but little of interest to record as having occurred during the past year. No fresh species has been reported from any part of the county since the date of my last paper, but I have received information respecting the occurrence, prior to the year 1877, of two birds, which constitute additions to our catalogue, augmenting the number of our Hertfordshire birds to 180 species. The species referred to are the grey phalarope and the whooper swan.

1. THE GREY PHALAROPE (*Phalaropus fulicarius*).—A grey phalarope was shot some years ago by Mr. Latchmore, at Grove Mill, almost close to the town of Hitchin, and was in his possession until quite recently. The grey phalarope was first described as a British bird in the year 1757, by Thomas Bolton, in the 'Philosophical Transactions.' It belongs to the class grallatores or waders. It is an irregular or gipsy migrant to the British Isles, but has occasionally visited our shores in large numbers. Mr. John H. Gurney, of Northrepps, records an important immigration of this species which took place between the 20th of August and the 8th of October, in the year 1866. Mr. Gurney estimates that during that period upwards of five hundred of these beautiful and harmless birds were slaughtered. The grey phalarope is a circumpolar bird. It breeds in Iceland, Spitzbergen, and on the islands and shores of the Arctic Ocean. Like others of its class it is driven southward during winter by the exigencies and necessities of life, but it retires with reluctance, and in mild seasons remains to winter among the Norwegian fjords. Its occasional visits to our coasts are probably the result of exceptional cold or storms. Mr. Gurney states that in September, 1866, when so large a number of phalaropes made their appearance on the coast of Sussex, severe gales had previously prevailed, and icebergs came farther south than had ever been known before. The plumage of the grey phalarope varies in colour to an unusual extent in accordance with the period of the year. During the breeding-season its prevailing colour is a reddish chestnut brown, which, in winter, shades off to a delicate grey. Admirable specimens of this species, in both summer and winter plumage, may be seen and examined in Mr. Booth's Museum, Dyke Road, Brighton.

2. THE WHOOPER SWAN (*Cygnus musicus*).—The Rev. W. Tyrwhitt Drake informs me that a pair of whooper swans frequented the water at Water End, near Great Gaddesden, during the winter of either 1875 or 1876. The whooper swan is a pretty regular winter migrant to the British Isles, and is met with, not unfrequently, in large numbers on the Norfolk coast. I have seen whoopers exhibited for sale on several occasions in Leadenhall Market. It nests*

* Seebohm's 'British Birds,' vol. iii, pp. 85–86.

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on the bleak prairies or tundra of Siberia, and in Scandinavia, beyond the limit of forest-growth. Mr. Henry Seebohm met with whoopers in abundance in the valley of the Petchora, and was successful in finding numerous nests on the delta of that river. The whooper is readily distinguished from other swans by its beak and head; the lower portion of the beak being black, and the posterior or higher portion being a conspicuous yellow. Respecting it, Montague* writes as follows:—"Having killed one of these species out of a flock of ten or twelve, its companions flew round several times, making a most melancholy cry before they flew off. This reminded us of the solemn dirge of the dying swan described by the ancient poets, and may possibly have given rise to those accounts; only by them it was supposed to be sung by the dying bird."

The following observations on the arrivals of our migrants and other visitants have been reported.

Summer Migrants.

Species.	Locality.	Date.	Observer.
Nightingale (*Daulias Luscinia*)	Hertford	Apl. 5	R. T. Andrews.
	Hailey Hall, Hertford	,, 10	H. C. Heard.
	St. Albans	,, 17	Henry Lewis.
	Sawbridgeworth	,, 20	Miss Simpson.
	Odsey Grange, Royston	,, 23	H. G. Fordham.
	Hitchin	,, 24	W. Hill. jun.
	Watford	,, 24	J. Hopkinson.
	Harpenden	,, 25	J. J. Willis.
	Fanhams Hall, Ware	,, 26	R. B. Croft.
	Hunton Bridge, Watford	May 1	J.E.L.
Redstart (*Ruticilla phœnicurus*)	St. Albans	Mar. 28	Henry Lewis.
	Hertford	Apl. 11	G. Shrimpton.
Wheatear (*Saxicola Œnanthe*)	St. Albans	Mar. 22	Henry Lewis.
	Barton	Oct. 21	W. H. Hare.
Whitethroat (*Sylvia rufa*)	St. Albans	Apl. 25	Henry Lewis.
Blackcap (*Sylvia atricapilla*)	Hunton Bridge, Watford	Mar. 27	J.E.L.
Chiff-Chaff (*Phylloscopus collybita*)	St. Albans	,, 23	Henry Lewis.
	Fanhams Hall, Ware	,, 23	R. B. Croft.
	Hitchin	,, 26	W. Hill, jun.
	Hunton Bridge, Watford	,, 26	J.E.L.
	Watford	Apl. 4	C. Fry.
Willow Wren (*Phylloscopus Trochilus*)	Hunton Bridge, Watford	Mar. 24	J.E.L.
	Watford	Apl. 11	A. Barraud.
	St. Albans	,, 25	Henry Lewis.
Sedge Warbler (*Acrocephalus schœnobœnus*)	Hunton Bridge, Watford	,, 27	J.E.L.
Spotted Flycatcher (*Muscicapa Grisola*)	Hunton Bridge, Watford	May 12	J.E L.
	Odsey Grange, Royston	,, 17	H. G. Fordham.
Swallow (*Hirundo rustica*)	Hertford	Apl. 1	R. T. Andrews.
	Watford	,, 4	J. Hopkinson.
	Cassiobury, Watford	,, 4	C. Fry.
	Hailey Hall, Hertford	,, 12	H. C. Heard.
	Royston Heath	,, 15	E. O. Fordham.

* 'Ornithological Dictionary,' ed. 1833, p. 544.

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Species.	Locality.	Date.	Observer.
Swallow	Elstree	Apl. 16	E.P.Thompson.
(*Hirundo rustica*)	Odsey Grange, Royston	,, 18	H. G. Fordham.
	Harpenden	,, 18	J. J. Willis.
	St. Albans	,, 23	Henry Lewis.
	Hitchin	,, 24	W. Hill, jun.
	Fanhams Hall, Ware	,, 28	R. B. Croft.
(Last seen)	Ashwell	Oct. 24	H. G. Fordham.
House Martin	Boxmoor	Apl. 22	J.E.L.
(*Chelidon urbica*)	St. Albans	,, 24	Henry Lewis.
	Harpenden	,, 25	J. J. Willis.
	Fanhams Hall, Ware	May 5	R. B. Croft.
Swift	St. Albans	,, 6	Henry Lewis.
(*Cypselus Apus*)	Hitchin	,, 7	W. Hill, jun.
	Harpenden	,, 8	J. J. Willis.
	Ashwell	,, 9	E. G. Fordham.
	King's Langley	,, 12	J.E.L.
	Fanhams Hall, Ware	,, 12	R. B. Croft.
Wryneck	St. Albans	Apl. 8	Henry Lewis.
(*Iynx torquilla*)	Elstree	,, 9	E.P.Thompson.
	Watford	,, 21	A. Barraud.
Cuckoo	Hailey Hall, Hertford	,, 13	H. C. Heard.
(*Cuculus canorus*)	Hertford	,, 15	R. T. Andrews.
	Harpenden	,, 22	J. J. Willis.
	St. Albans	,, 22	Henry Lewis.
	Watford	,, 23	J. Hopkinson.
	Hitchin	,, 28	W. Hill, jun.
	Royston	,, 28	W. Reynolds.
Turtle Dove	Royston	May 3	E. S. Fordham.
(*Turtur communis*)	Odsey Grange, Royston	,, 10	H. G. Fordham.
Landrail	Harpenden	Apl. 25	J. J. Willis.
(*Crex pratensis*)	Odsey Grange, Royston	,, 30	H. G. Fordham.
	Hailey Hall	May 1	H. C. Heard.
	Hitchin	,, 5	W. Hill, jun.
	St. Albans	,, 9	Henry Lewis.

Spring, Autumn, and Winter Visitants.

Redwing	St. Albans	Oct. 28	Henry Lewis.
(*Turdus Iliacus*)	(large flights)		
Fieldfare	St. Albans	Nov. 21	Henry Lewis.
(*Turdus Pilaris*)	Little Gaddesden	,, 24	G. Underwood.
(Last seen)	Odsey Grange, Royston	Mar. 2	H. G. Fordham.
Ring Ousel	Hunton Bridge, Watford	Sep. 16	J.E.L.
(*Turdus torquatus*)			
Brambling	Hemel Hempstead	Dec. 24	Henry Wyman.
(*Fringilla montifringilla*)			
Snow Bunting	Hemel Hempstead	,, 27	Henry Wyman.
(*Plectrophanes nivalis*)			
Hooded Crow	Odsey Grange, Royston	Mar. 5	H. G. Fordham.
(*Corvus cornix*)	Hyde Hall	,, 31	E. D. Fordham.
	Odsey Grange, Royston	Oct. 25	H. G. Fordham.
	Great Gaddesden	Nov. 20	H. Procter.
Woodcock	Odsey Grange, Royston	Oct. 21	H. G. Fordham.
(*Scolopax rusticola*)	Great Gaddesden	Nov. 30	H. Procter.

Miscellaneous Notes.

Redbreast (*Erithacus rubecula*).—Mr. H. C. Edmonds, of Cole Green Farm, near Hertford, informs me that he found in a bank,

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near a ditch, a robin's nest, in which were two purely white eggs. He was able carefully to observe the hen bird, and he thinks from the appearance of the eggs that she had been sitting about a couple of days. He removed the white eggs, replacing them with two others taken from the deserted nest of a hedge-sparrow, and found that incubation was continued without interruption. Robins seldom commence sitting until at least five eggs have been laid, and the fact that, in this case, incubation was commenced with only two, and that those two were of a purely white colour, is most curious. Referring to the song of the robin, Mr. Henry Lewis sends me the following note:—"Robins nest early in the year, and I believe that they also moult early. I have seen them in my garden in moulting condition by the middle of June, and they come into full song again early in the autumn." That the song of the robin is heard throughout the autumn and winter months is well known.

Wheatear (*Saxicola Œnanthe*).—Mr. Henry Lewis informs me, on the authority of Mr. Hare, that a wheatear nested this season at Barton, near Hitchin, and that on the 21st of October several young birds were still to be seen in the neighbourhood. The wheatear is a regular summer migrant to the British Isles. It frequents, for the most part, wild open districts, and there is no reason why it should not select as its breeding-home the Barton Hills. It must, however, be stated that it appears to prefer Scotland and the North of England, and has generally been observed in Hertfordshire on its spring and autumn migrations. We were fortunate in being able to observe a pair of wheatears when driving over Amersham Common on the 11th of August.

Blackcap (*Sylvia atricapilla*).—Blackcaps were unusually abundant, about the end of March and the beginning of April, in the neighbourhood of Hunton Bridge. I feel confident that I had at least a score in my own garden.

Ring-Ousel (*Turdus torquatus*).—I am pleased to be able to state that a ring-ousel paid us a visit on the 16th of September and remained for about twenty minutes on the lawn in front of my house. We watched for it on the following day, but were not fortunate enough again to see it. The ring-ousel is a spring and autumn visitant in Hertfordshire, it breeds in the north of England and Scotland, and then retires to spend its winter on the shores of the Mediterranean.

Golden Oriole (*Oriolus galbula*).—A golden oriole was shot on the 4th of June on the borders of Sherrards Park Wood, Digswell, near Welwyn, and has been mounted by Mr. Lloyd, of St. Albans. In the year 1881 I was able to report the nesting of the golden oriole in the parish of Amwell, near Ware, and I am pleased to be able to register its occurrence a second time.

Chaffinch (*Fringilla cœlebs*).—The Hon. Miss Albertine F. E. Grosvenor, of Moor Park, has sent me the following interesting anecdote respecting the chaffinch:—"On the 11th of May a chaffinch deposited an egg on a window-sill, about sixty feet from the ground, the sill being a stone slab 20 inches in width. The egg

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was laid about 8 o'clock in the morning, close up to the window, and in a position from which nothing but a very strong wind could dislodge it. I waited for about an hour to see if the mother would return to notice it, but although both of the hen chaffinches that feed at my window showed themselves, and one gave slight signs of distress, no bird went near the egg." It is possible that the chaffinch may have failed to complete her nest in time to receive her first egg, or her nest may have been wantonly destroyed.

Snow-Bunting (*Plectrophanes nivalis*).—Mr. H. Wyman observed a flock of snow-buntings, from the 27th to the 29th of December, frequenting hawthorn trees near Marlowes, Hemel Hempstead. They appeared to be feeding greedily on the berries.

Hooded Crow (*Corvus Cornix*).—Mr. E. O. Fordham reports that on the 31st of March he observed, near Hyde Hall, between twenty and thirty Royston crows busily engaged in feasting upon the carcase of a single sheep.

Greater Spotted Woodpecker (*Picus major*).—In the month of January three of these birds were shot near Hertford and brought to Mr. G. Shrimpton, of Port Vale, to be mounted. On the 2nd of last February I observed one on the branch of a tree, close to the road between St. Albans and Leverstock Green.

Kestrel (*Falco tinnunculus*).—Shortly before reaching the "Eagle," near Nash Mills, on the 23rd of last September, we observed a beautiful kestrel in splendid plumage, perched upon the telephone wire close to the road. It flew up just as we approached, but again alighted on the wire about 50 yards in advance. It remained in this position until we had passed by it, and then, after fluttering for a few moments in the air just above us, as if determined to exhibit itself to the best possible advantage, darted off in the direction of the canal.

Quail (*Coturnix communis*).—I am informed by Mr. Hare that quails have been abundant during the autumn on the Barton Hills, and that a few of them have been shot.

Woodcock (*Scolopax rusticola*).—I have received the following note respecting the nesting of the woodcock in Hertfordshire from our President, Mr. F. M. Campbell, F.L.S.—"In April, 1886, I met with a woodcock's nest in the wood called Cowheath. It was a few feet from a ride, on a slope with a southern aspect. The keeper informed me that he had seen the female on the nest, and that she sat very close. The nest was afterwards deserted and I have one of the eggs. Another keeper informs me that he found two nests in 1885 in an adjoining wood called Bramblers. I also hear that in June of the same year young woodcocks were identified by an experienced naturalist on Hertford Heath." The nesting of woodcocks in Hertfordshire has been recorded on previous occasions, but it is the first time that I have registered its occurrence. The woodcock has always been regarded as a winter migrant, but the fact that numerous instances of its nesting in the Midland and Southern counties have now been established, raises the important question as to whether it may not more correctly be considered as a

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resident. "The rule amongst migrants," writes Mr. H. Seebohm,* "unquestionably is, that whenever the breeding-range overlaps the winter range, the birds in the overlapping districts are residents." If this rule did not admit of exceptions we might at once accept the woodcock as a resident in our country, but such is not the case. The woodcock is an early breeder, and evidence quoted by Mr. Seebohm seems to show that birds, hatched in our district, leave us in August on their journey southward, and that their place is not filled up by the advent of migrants from Scandinavia and the north until the middle of October. Any information tending to throw light on this most interesting question would be most welcome. The fact that the woodcock always migrates by night renders observations respecting its migratory habits unusually difficult.

Landrail or Corncrake (*Crex pratensis*).—Mr. G. Shrimpton, of Port Vale, informs me that a corncrake was shot on Molewood Road, near Hertford, on the 30th of December. In the year 1884 I reported that a corncrake was picked up dead on the 3rd of December, between St. Albans and Colney. These are unusual occurrences. The food of the corncrake is mainly composed of worms, grubs, and beetles, and it is difficult to understand how the bird shot on the 31st of December could have managed to exist to that date. It is probable that it was saved from starvation by a timely death.

Black Tern (*Hydrochelidon nigra*). — Two black terns were observed by Mr. Henry Lewis, on the 24th of April, between Park Street and Moor Mill; one of them was shot and has been mounted by Mr. Luff, of St. Albans. Mr. J. Beningfield, of Ware, has kindly sent me the following note:—"Whilst on a survey on the banks of the Stort, in the parish of Gilston, on the 13th of last May, to ascertain the cause of a large field being, for months past, flooded, I observed a pair of black terns flying over the flooded land. They were very tame, and frequently came within a few yards of me." Mr. Beningfield also informed me that he shot six of these birds, some years ago, near Broxbourne.

Herring Gull (*Larus argentatus*). — Mr. Simons, of King's Langley, informs me that when driving along the road towards Hemel Hempstead in his cart, on the 23rd of September, he knocked over with his whip a large gull. He took it home with him and endeavoured to keep it alive, but without success. It proved to be a herring gull.

Great Northern Diver (*Colymbus glacialis*).—I am informed that a great northern diver was observed on one of the Tring reservoirs, by the keeper, on the 15th of last February. I have been able to report this bird, the largest of our water-fowl, on but one previous occasion.

Crested Grebe (*Podiceps cristatus*).—Mr. Henry Seebohm informs me that he was fortunate in discovering a nest of this beautiful grebe on one of the Tring reservoirs. Several years ago the Rev. Harpur Crewe informed me that the crested grebe habitually nested on these waters.

* 'British Birds,' vol. iii, p. 232.

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Cormorant (*Phalacrocorax carbo*).—On the 5th of September, 1885, Mr. A. Holland Hibbert was fortunate in being able to observe a cormorant flying over the Lea Farm, about two miles from Watford. It first settled on a tree, and eventually flew off towards Gullet Wood. In March last another cormorant was shot near Park Street by Mr. Gee. It would appear that even the immense wing-power possessed by the cormorant is insufficient to protect it against the extreme violence of occasional gales. It is impossible to suppose that it visits Hertfordshire willingly, for the sake of enjoying its unsurpassed woodland scenery.

Tufted Duck (*Fuligula cristata*).—I have again to record the visit of a pair of tufted ducks to the Lynch Lake, near Hoddesdon. Mr. Henry Manser tells me that they frequently took short flights, but soon returned again to the lake. I have before stated that Mr. Manser has succeeded in domesticating this species on his lake, and the tame birds appear to be visited periodically by their roving relatives.

Stormy Petrel (*Procellaria pelagica*).—A stormy petrel was captured alive near the Midland Railway, not far from St. Albans, on the 11th of December. This is the fourth occasion on which I have reported the capture of this bird, the smallest of our sea-fowl, within the borders of Hertfordshire.

Bean Goose (*Anser segetum*).—A very large flight of wild geese was observed passing over Hitchin on the first day of the present year. Mr. James Tuke, who reported to me the occurrence, added the expressive words, "delightful was the clang thereof."

The Flights of Birds.—I have already alluded to an enormous flight of geese, observed by Mr. J. H. Tuke, passing over Hitchin. I have received very interesting reports respecting similar flights of redwings and starlings. A policeman on duty at St. Albans on the night of the 28th of October heard, as distinctly as possible, the sound of a vast multitude of birds passing over the city. From the description given there can be but little doubt that they were redwings, and I may add that occurrences of the kind are by no means uncommon. A few years ago my friend Mr. Clarence Fry directed my attention to a vast flight passing over the northern end of Watford; the dusk of evening forbade the possibility of our obtaining even a glimpse of the birds, but the faint plaintive note of the redwing was distinctly and continuously audible. Mr. Henry Lewis has sent to me a graphic description of the assembling of an enormous multitude of starlings on one of the earlier days of October, at a favourite roosting-place near No Man's Land. He describes them as arriving in hundreds of thousands from all parts of the compass, and states that when standing on the opposite hill he could hear the noise of their voices like the roar of the ocean on a pebbly shore. Starlings have been unusually numerous during the past year; they are, as every one knows, always resident in our county, but their numbers are enormously increased by migration from the north of Europe during the winter months. It is probable that no inconsiderable portion of the immense cloud of birds observed at No Man's Land consisted of starlings just arrived from abroad.

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Albino Sports.—Albino sports continue to be of frequent occurrence. Perhaps the most remarkable instance reported is that of a pair of partridges with white wings and tails shot near Stevenage by Mr. W. Garratt, of Sele Mill, Hertford.

General Remarks.—In my last paper I alluded to the wholesale destruction of redwings, fieldfares, and thrushes, by the influence of cold and hunger during the early part of the year 1886. During the present year large numbers of these birds have again been sufferers, but, as far as I have been able to obtain reliable information, not to the same extent as then reported. During the long continuance of snow in January all our resident birds suffered very severely from hunger; blackbirds, thrushes, and tits readily consorted with sparrows, chaffinches, etc., and fed contentedly on crumbs of bread and grain of any description, as though worms, grubs, insects, and berries had ceased to exist. The singing of the thrush had commenced with unusual vigour before the expiration of the old year, but it ceased altogether during the snow, and the welcome sound was only heard occasionally during the month of February. Even swallows for once became the victims of climatic influence. Numbers were picked up dead and dying in different parts of Hertfordshire soon after their arrival. This would doubtless result from the lateness of our spring, and the consequent absence of the insect-life usually abundant in April.

Of golden plovers I have received but one report. They have been extremely scarce throughout the season. Perhaps it would not be difficult to account for their absence. In my report for the year 1882 I stated that the golden plover had long been regarded as the special harbinger of rain, and its specific name, *Charadrius pluvialis*, would seem to indicate that this popular belief has been more or less adopted by scientists. It is probable that the long continuance of dry weather, or very possibly the atmospheric causes which combine to promote such a result, may have proved sufficient to influence the acute migratory instincts of this sensitive bird, and to have directed its course to other shores. Partridges have been generally abundant, and the same may be reported respecting the snipe and the woodcock.

I can hardly conclude my paper without offering my best thanks to Mr. Henry Lewis, of St. Albans, for the great assistance he has rendered me throughout the year. I trust that he will continue to help me in the future as he has done in the past, and that our members generally will kindly co-operate in endeavouring to make our annual ornithological report as comprehensive and interesting as possible.

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XVIII.

METEOROLOGICAL OBSERVATIONS TAKEN AT WANSFORD HOUSE, WATFORD, DURING THE YEAR 1886.

By JOHN HOPKINSON, F.L.S., F.G.S., F.R.Met.Soc.

Read at Watford, 19th April, 1887.

LONGITUDE of Station, 0° 23′ 40″ W.; Latitude, 51° 39′ 45″ N. Ground-level at thermometer-stand and rain-gauge 223 feet, and cistern of barometer 234 feet above Ordnance Datum. All the observations are taken at 9 a.m. Further particulars are given in the report for the year 1883.*

This is the ninth annual report of my meteorological observations at Wansford House, and, owing to my removal to St. Albans at the end of the year to which it relates, it is my last annual report for Watford. The observations are continued at St. Albans.

The monthly means and other results of the daily observations in 1886 are given in the accompanying tables (pp. 170, 171); and from these tables the following summary for the seasons (winter including Dec. 1885 from the previous report) is deduced, results for Greenwich Observatory being added for comparison as usual.

MEANS FOR THE SEASONS FROM DEC. 1885 TO NOV. 1886, AT WATFORD.

Seasons, 1885–86.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	30·016	35·1	9·7	·180	90	5·64	48	7·9
Spring	29·960	46·5	15·7	·260	81	8·15	52	7·2
Summer.....	29·986	60·9	18·9	·373	74	4·50	34	6·2
Autumn.....	29·932	51·8	14·3	·335	88	8·31	49	6·9

THE SAME AT GREENWICH.

Seasons, 1885–86.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	29·997	36·2	9·0	·187	87	5·36	45	7·3
Spring	29·941	46·4	17·0	·253	79	6·62	42	7·1
Summer.....	29·960	60·9	21·5	·398	74	4·07	32	6·3
Autumn.....	29·908	52·0	14·6	·332	85	5·67	39	6·8

* 'Trans. Herts. Nat. Hist Soc.,' Vol. III, Part 5, p. 181.

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Results of Meteorological Observations taken at Wansford House, Watford, in 1886.

Months.	Pressure of the Atmosphere.	Temperature of the Air.										Humidity of the air.		
		9 a.m.	Means of		Adopted Mean.	Mean Daily Range.	Absolute Min. and Max.				Absolute Range.	Dryness.	Tension of Vapour.	Relative Humidity.
			Min.	Max.			Min.	Date.	Max.	Date.				
	ins.	°	°	°	°	°	°	°	°	°	°	°	in.	%
January	29·678	34·8	30·0	40·2	35·0	10·2	13·7	8th	51·6	2nd	37·9	2·7	·179	90
February	30·156	32·7	28·9	37·4	33·0	8·5	18·4	10th	46·5	13th	28·4	3·1	·163	88
March	29·992	38·9	33·4	45·8	39·4	12·4	19·8	7th	62·0	24th	42·3	3·0	·211	87
April	29·944	47·1	39·3	55·7	47·4	16·4	31·0	12th	68·9	28th	37·9	6·6	·253	78
May	29·946	53·7	43·1	61·5	52·8	18·4	28·0	1st	75·4	7th	47·4	7·3	·316	77
June	30·000	58·5	48·1	66·8	57·8	18·7	38·3	5th	77·6	28th	39·3	10·1	·279	70
July	29·935	63·1	52·8	72·0	62·6	19·2	42·7	28th	84·1	4th	41·4	9·3	·415	73
August	30·022	61·7	53·4	72·1	62·4	18·7	43·3	20th	87·2	31st	43·9	6·5	·426	79
September	30·055	58·6	50·8	68·1	59·2	17·3	39·1	18th	83·2	1st	44·1	5·7	·401	82
October	29·809	52·4	47·0	59·9	53·1	12·9	35·3	22nd	77·4	4th	42·1	2·8	·356	90
November	29·932	42·6	35·8	49·6	43·0	12·8	27·0	23rd	58·8	1st	31·8	2·4	·249	91
December	29·708	35·6	30·7	41·8	36·0	11·1	18·9	3rd	54·0	6th	35·1	3·2	·184	88
Year	29·931	48·3	41·2	55·9	48·5	14·7	13.7	Jan.8	87·2	Aug 31	73·5	5·2	·286	83

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RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT WANSFORD HOUSE, WATFORD, IN 1886 *(continued)*.

MONTHS.	RAINFALL.					CLOUD.			WIND.									
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount, 0-10.	No. of days of		Mean Force, 0-12.	Number of days of								
	Ins.	Ins.	Date.	Rain or Snow.	Snow only.		Clear Sky.	Over-cast.		N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm.
January.....	3·63	·34	5th	24	15	7·9	4	20	1·5	2	2	1	3	1	4	7	8	3
February	·82	·22	2nd	9	7	8·9	2	21	1·0	3	5	7	2	3	0	1	3	4
March	1·87	·33	1st	16	8	8·0	5	19	1·8	2	4	6	3	5	4	2	3	2
April	1·85	·65	7th	16	3	7·0	3	12	2·0	2	8	3	4	2	5	4	2	0
May	4·43	1·04	12th	20	0	6·5	3	11	1·5	1	3	4	5	4	6	3	4	1
June	1·46	·41	2nd	9	0	5·7	4	9	1·7	3	6	3	4	0	2	4	6	2
July	2·08	·39	25th	12	0	6·3	6	7	1·6	2	2	0	3	4	6	7	4	3
August	·96	·26	12th	13	0	6·7	4	12	1·4	4	3	0	3	1	8	5	5	2
September	1·98	·51	2nd	11	0	6·5	5	10	1·8	3	7	1	9	1	6	2	1	0
October	3·61	·61	15th	22	0	7·1	2	17	1·6	2	4	6	5	2	5	1	4	2
November	2·72	·70	5th	16	0	7·2	4	17	1·0	1	3	1	2	4	5	4	5	5
December	4·50	1·65	26th	19	7	7·1	7	14	1·8	1	0	1	3	2	4	10	6	4
Year	29·91	1·65	Dec. 26	187	40	7·1	49	169	1·6	26	47	33	46	29	55	50	51	28

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In the previous report the means of some of the principal results of observations taken during the eight years 1878–85 are given. The following table shows the difference in 1886 from the means of these eight years, for each month, and for the year.

DIFFERENCE IN 1886 FROM MEANS OF 1878-85, AT WATFORD.

Months.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	in.	°	°	in.	%	ins.		
January	—·420	—1·1	+0·9	—·011	+1	+1·47	+10	+0·3
February	+·222	—7·2	—2·3	—·056	—1	—2·07	— 9	+1·3
March	—·023	—2·1	—2·8	+·001	+5	+0·36	+ 4	+1·9
April	—·046	+1·3	—0·2	+·011	+1	+0·55	+ 2	+0·8
May	—·031	+0·3	=	+·024	+6	+2·28	+ 6	+0·3
June	+·042	—0·6	+1·4	—·092	—4	—1·78	— 7	—0·9
July	+·012	+1·2	+2·0	+·005	—1	—0·46	— 3	—0·3
August	+·097	+1·3	+2·7	+·008	+2	—1·74	+ 1	—0·3
September	+·104	+2·4	+1·2	+·016	—1	—0·93	— 3	+0·1
October	—·124	+5·4	—0·2	+·068	+3	+0·48	+ 5	+0·5
November	—·008	+1·3	+1·1	+·016	+3	—0·19	— 3	+1·7
December	—·279	—0.1	+1·2	—·015	—2	+2·05	+ 3	—0·2
Year	—·038	+0·1	+0·4	—·002	+1	—1·08	+ 6	+0·4

The year 1886 commenced with very cold weather, February being an especially cold month; but, towards the end of the year, up to December, the weather was warmer than usual, a cold period coming on again in December and lasting far into 1887. The mean pressure of the atmosphere was below the average; the lowest pressures recorded at 9 a.m. were 28·673 ins. on 16th Oct. and 28·384 ins. on 9th Dec., and the highest were 30·745 ins. on 8th Feb. and 30·742 ins. on 24th Nov., giving a range of 2·361 ins.* The mean temperature for the whole year was about the average. The very low minimum of 13°·7 was recorded on the 8th of January, and minima below 20° occurred in February, March, and December. There were no very high maximum readings. The daily range of temperature was a little above the average. The rainfall was heavy, in May and December especially, but very slight in February and August. It was, however, below the average of our eight-year period. The number of rainy days also was large. The relative humidity was about the average.

Compared with the previous year, in 1886 the mean temperature was 0°·5 higher, the mean daily range the same, the relative humidity 2 per cent. greater, and the rainfall 0·11 in. less. Rain (or snow) fell on 4 days more in 1886 that in 1885, and snow (only) on 28 days more. The sky was more cloudy generally,

* At 7·30 p.m. on 8th Dec. the mercury stood at 28·321 ins., increasing the range in the year to 2·424 ins.

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much less frequently clear of cloud, and much more often completely overcast. The estimated force of the wind was about the same as in 1885.

In the winter of 1885-86 (Dec. to Feb.) the mean pressure of the atmosphere was high, but about the average of our period. The mean temperature was very low, the relative humidity was about the average, the rainfall was rather small, and the number of rainy days was about the average. In the spring (March to May) the mean pressure was again about the average for the season, the mean temperature rather low, the relative humidity very high, and the rainfall and number of rainy days were great (owing to the wet May). In the summer (June to Aug.) the mean pressure was above the average, the mean temperature rather high (the daily range being considerable), the relative humidity about the average, and the rainfall and number of rainy days were very small. In the autumn (Sept. to Nov.) the mean pressure was about the average, the mean temperature very high, the relative humidity rather high, the rainfall, though heavy, a little below the average of our period, and the number of rainy days about the average. The difference between these seasons and the means of the seasons from Dec. 1877 to Nov. 1885 is shown in the following table.

DIFFERENCE IN 1885–86 FROM MEANS OF 1877–85, AT WATFORD.

Seasons, 1885–86.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	+·016	−2·8	−0·4	−·024	+1	−1·86	− 1	+ 4
Spring	+·008	−0·3	−1·0	+·012	+5	+2·09	+13	+10
Summer.....	+·044	+0·6	+2·1	−·027	−1	−3·85	−11	− 6
Autumn.....	−·009	+3·2	+0·6	+·033	+2	−0·64	+ 1	+ 2

The following notes record some of the principal features of the weather in each month.

JANUARY.—Rather cold and dull, with a rather humid atmosphere of very low pressure, and with much rain and snow. The weather was very variable throughout the month, and there were sudden changes in temperature. The 1st to 5th, 13th to 15th, and 31st were warm. Rain or snow fell every day but 2nd, 8th, 9th, 14th, 18th, 26th, and 27th. Westerly winds prevailed. Min. temp. below 32° on 21 days, below 22° on 2 (7th and 8th), above 44° on 2 (1st and 2nd); max. above 42° on 11.

FEBRUARY.—Excessively cold, very dull, with a rather dry atmosphere of high pressure, and with very little rain or snow. The coldest February of our period by 4°·3, and probably the coldest for many years; the only rather warm days were 1st and 2nd, and 12th to 14th. No rain or snow fell from 4th to 10th,

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nor from 16th to 26th. Easterly winds prevailed. Min. temp. below 32° on 20 days, below 22° on 3 (7th, 9th, and 10th); max. above 42° on 2 (2nd and 13th).

March.—Very cold and dull, with a very humid atmosphere of average pressure, and with about an average rainfall. The coldest March of our period, except that of 1883; the very cold weather lasted until 18th, after which it became much warmer. No rain fell from 7th to 17th, but from 18th to 31st rain fell every day but 2 (24th and 25th). Min. temp. below 32° on 18 days (1st to 18th), below 22° on 2 (7th and 17th); max. above 52° on 12 (19th to 29th, and 31st).

April.—Of average temperature and brightness, with an atmosphere of average humidity and pressure, and with about an average rainfall. A few days (23rd to 28th) were much warmer than the rest, and it is owing to these that the mean temperature is slightly above the average of our period. There was a sudden fall in temperature on 29th. Most of the rain fell before the 11th. North-easterly winds prevailed. Min. temp. below 42° on 23 days, below 32 on 2 (11th and 12th); max. above 52° on 19, above 62° on 6.

May.—Of average temperature and brightness, with a very humid atmosphere of average pressure, and with a very heavy rainfall. The first few days were cold; the 6th to 9th were very warm; but from 10th to 11th there was a rapid fall in temperature. No rain fell until 10th, and then, coincidently with the fall in temp., there was rain every day except 23rd and 28th, the average daily fall for the last 22 days of the month being 0·2 in. The heavy falls in addition to the max. of 1·04 in. on 12th were 0·95 in. on 24th, 0·52 in. on 21st, and 0·48 in. on 22nd. Min. temp. below 42° on 12 days, below 32° on 3 (1st, 2nd, and 4th); max. above 62° on 16, above 72° on 3 (6th, 7th, and 8th). The wettest May of our period; the rainfall was so heavy in the western and midland counties of England that very serious floods occurred, chiefly about the middle of the month; and in our own county the River Beane overflowed and caused much damage.

June.—Rather cold, very bright, with a very dry atmosphere of more than average pressure, and with a small amount of rain. The 1st and 2nd, 6th to 9th, and 24th to 30th were much warmer than the rest of the month. Rain fell only on 1st, 2nd, 10th to 14th, 18th (only 0·02 in.), and 22nd (0·02 in.), the last half of the month thus being almost without rain. Min. temp. below 52° on 20 days, below 42° on 3 (4th, 5th, and 6th); max. above 62° on 24, above 72° on 6.

July.—Rather warm and bright, with a rather dry atmosphere of average pressure, and about an average rainfall; the 1st to 7th were very warm (3rd, 4th, and 6th especially), and also very bright, there being no cloud (at 9 a.m.) except on 2nd; the 18th to 22nd also were very warm (21st especially). No rain fell until 11th, there having thus been, from 14th June, a period of 26 days with only 0·04 in. of rain. Min. temp. below 52° on 18 days; max. above 72° on 13, above 82° on 4 (3rd, 4th, 6th, and 31st).

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AUGUST.—Rather warm, of average brightness, with a rather humid atmosphere of considerable pressure, and with a small amount of rain. The 1st to 5th were cold, 6th to 8th warm, 9th to 19th cold, and 20th to 31st warm, 29th and 31st being very warm. From 1st to 19th rain fell every day but 3rd to 7th, and 14th; after 19th none fell. Min. temp. below 52° on 10 days; max. above 62° every day but 2nd (61°·8), above 72° on 15 days, above 82° on 2 (86°·6 on 30th, 87°·2 on 31st).

SEPTEMBER.—Warm, of average brightness, with a rather dry atmosphere of considerable pressure, and with a small amount of rain. The 1st was a very warm day (max. 83°·2), the 2nd, 4th, 13th, and 14th were above the average of the month, and towards the end of the month the weather became much cooler. No rain fell from 11th to 24th. Min. temp. below 42° on 3 days (17th, 18th, and 19th); max. above 62° every day but 4 (23rd, 24th, 25th, and 27th), above 72° on 8, above 82° on 1 (1st).

OCTOBER.—Very warm, of average brightness, with a rather humid atmosphere of less than average pressure, and with a very heavy rainfall. The warmest October of our period by 2°·8; the 1st to 5th were exceptionally warm, the 6th to 12th, and 29th to 31st, about the average of the month, and the 13th to 28th about the usual October temperature. Rain fell every day from 9th to 18th with a total of 2·23 ins., and an average of 0·22 ins. per day for this period. Min. temp. below 42° on 3 days (14th, 22nd, and 23rd); max. above 52° every day but 2 (26th and 27th), above 62° on 6 (1st to 6th), above 72° on 3 (1st, 4th, and 5th).

NOVEMBER.—Rather warm but very variable in temperature, of nearly average brightness, with a rather humid atmosphere of average pressure, and with an average rainfall. The first two days were the warmest; the 8th, 19th, and 23rd were cold. Rain fell every day from 9th to 17th. Min. temp. below 32° on 7 days; max. above 52° on 8.

DECEMBER.—Rather cold, of average brightness, with a rather dry atmosphere of very low pressure, and with a very heavy rainfall. The 1st to 5th were very cold, 6th to 15th warm, and 16th to 31st very cold, the 18th to 21st being exceptionally so (mean temp. 28°·1). Rain fell every day from 6th to 15th, but, including snow, nearly as much fell on 26th as on these ten days together. This was one of the heaviest falls of snow we have experienced. Min. temp. below 32° on 15 days, below 22° on 4 (3rd, 4th, 20th, and 22nd); max. above 42° on 14, above 52° on 1 (6th). On the 8th, at 7·30 p.m., the almost unprecedentedly low pressure of 28·321 ins. was recorded. This is lower by 0·210 in. than any of my previous records at Watford, the lowest before this being 28·531 ins. at 7 p.m. on 26th January, 1884.

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XIX.

REPORT ON PHENOLOGICAL PHENOMENA OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1886.

By JOHN HOPKINSON, F.L.S., F.G.S., etc.

Read at Watford, 19th April, 1887.

THERE is only one change to report in our staff of observers of Phenological Phenomena in 1886. Owing to the avocations of our Secretary, Mr. Lloyd, taking him to London instead of to Croxley, we lose him as an observer, and his station, Croxley, disappears from our table. The following are therefore the phenological stations where observations of the first flowering of the plants in the Royal Meteorological Society's list have been taken, as entered in the accompanying table:—

STATION.	N. LAT.		LONG.		OBSERVER.
Watford (1)	51	39	0	24w	Mrs. J. Hopkinson.
,, (2)	51	39	0	24w	Mrs. Applebee.
Harpenden	51	48½	0	21w	Mr. J. J. Willis.
Hertford	51	48	0	5w	Mr. R. T. Andrews.
Ware (Fanhams Hall)	51	49	0	1w	Major R. B. Croft.
High Wych, Sawbridgeworth	51	48½	0	8 E	Miss Simpson.
Hitchin	51	57	0	16w	Natural Hist. Club.
Odsey	52	1½	0	7w	Mr. H. G. Fordham.

The Insects observed being reported upon as usual by Mr. Silvester, and the Birds by Mr. Littleboy, the earliest observations only are here given. Of frog-spawn there is no special report; it was observed at Watford on the 21st of March; at Hertford on the 24th; at Harpenden on the 26th; and at Fanhams Hall, Ware, on the 27th. In 1885 the interval between the first and last recorded observation was a month (of 28 days); it 1886 it will be seen that it was barely a week.

The year 1886 was most decidedly a late year up to the period when our observations become few and far between—that is to the end of June. The whole of the 79 species were observed, and their mean gives 6·7 days late. The mean of the 60 selected species, most of which have been observed for 11 years and none for less than 9, shows 7·7 days late. Of these 60 species, 45 came into flower later than the mean of 1876-86, 12 earlier, and 3 on the same day as the mean; the years 1885 and 1886 being in this respect precisely the same.

Of the 30 species which come into flower by the middle of May (our spring flowers), 29 appeared after the mean date, and 1 on the same day as the mean; and of the 30 which come into flower later (our summer flowers), 16 appeared after the mean date, 12 before it, and 2 on the same day as the mean. The spring flowers were on the average a fortnight late and the summer flowers a day late.

Dividing the period of observation into three, the average date of the first 20 species, flowering from 22nd Jan. to 20th April, is 17·4 days late; of the next 20, from 21st April to 3rd June, 5·7

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DATES OF FLOWERING OF PLANTS OBSERVED IN 1886, WITH THE MEAN DATE FOR 1876–86.

No.	SPECIES.	WATFORD 1.	WATFORD 2.	HARPENDEN.	HERTFORD.	WARE.	HIGH WYCH.	HITCHIN.	ODSEY.	MEAN.
1.	*Anemone nemorosa* (wood anemone)	Apl. 3	.....	Apl. 3	Apl. 1	Apl. 12	.....	Mar. 30	.....	Mar. 13
2.	*Ficaria verna* (lesser celandine)	Mar. 21	Apl. 1	Mar. 26	.....	Mar. 24	Mar. 30	Mar. 21	.....	Feb. 21
3.	*Ranunculus acris* (upright crowfoot)	.....	May 21	Apl. 30	.....	.....	.....	May 28	.....	Apl. 23
4.	*Caltha palustris* (marsh marigold)	Apl. 21	Apl. 23	Apl. 18	Apl. 20	Apl. 19	Apl. 23	.....	.....	Mar. 24
5.	*Papaver Rhœas* (red poppy)	June 4	June 8	June 8	June 2	June 2	.....	.....	.....	May 29
6.	*Nasturtium officinale* (water-cress)	.....	July 1	.....	.....	.....	.....	June 14	.....	June 5
7.	*Cardamine pratensis* (cuckoo-flower)	.....	May 24	Apl. 30	Apl. 21	.....	.....	Apl. 24	.....	Apl. 13
8.	*Alliaria officinalis* (garlic-mustard)	Apl. 22	.....	May 2	Apl. 20	.....	.....	Apl. 26	.....	Apl. 14
9.	*Draba verna* (whitlow grass)	Apl. 1	.....	Mar. 31	Apl. 4	.....	.....	Mar. 29	.....	Mar. 9
10.	*Viola odorata* (sweet violet)	Apl. 3	Apl. 12	Mar. 24	Apl. 2	.....	Mar. 30	Mar. 27	Apl. 2	Feb. 13
11.	*Polygala vulgaris* (milkwort)	June 2	.....	May 31	June 7	.....	.....	May 22	May 23	May 8
12.	*Lychnis Flos-cuculi* (ragged Robin)	June 2	June 1	June 1	June 4	.....	.....	May 28	.....	May 24
13.	*Stellaria Holostea* (greater stitchwort)	Apl. 15	.....	Apl. 25	Apl. 14	Apl. 28	Apl. 14	Apl. 22	.....	Apl. 5
14.	*Malva silvestris* (common mallow)	June 14	July 1	.....	June 17	June 16	.....	.....	.....	June 6
15.	*Hypericum quadratum* (square St J.w.)	.....	.....	.....	.....	.....	.....	July 27	.....	July 5
16.	*H. pulchrum* (upright St. John's wort)	.....	Aug. 1	July 3	.....	.....	.....	July 15	.....	June 28
17.	*Geranium Robertianum* (herb Robert)	May 13	May 21	May 9	.....	.....	May 8	May 15	.....	Apl. 26
18.	*Euonymus europæus* (spindle-tree)	.....	.....	June 9	June 8	.....	.....	June 18	.....	June 1
19.	*Acer Pseudo-platanus* (sycamore)	.....	.....	May 7	May 4	.....	May 5	May 10	.....	Apl. 28
20.	*Æsculus Hippocastanum* (h. chestnut)	May 20	.....	May 21	.....	.....	May 16	May 9	.....	May 5
21.	*Cytisus Laburnum* (laburnum)	May 18	.....	May 25	May 14	.....	.....	May 16	.....	May 15
22.	*Trifolium repens* (Dutch clover)	May 15	.....	June 6	May 16	June 3	.....	May 30	.....	May 17
23.	*Lotus corniculatus* (bird's foot trefoil)	June 2	May 28	June 8	June 1	.....	May 29	May 30	.....	May 20
24.	*Vicia Cracca* (tufted vetch)	.....	July 1	July 2	.....	.....	.....	June 24	.....	June 24
25.	*V. sepium* (bush vetch)	.....	.....	May 8	May 17	.....	.....	May 31	.....	Apl. 27
26.	*Lathyrus pratensis* (meadow vetchling)	.....	.....	June 9	June 5	June 16	June 8	June 15	.....	June 3
27.	*Prunus spinosa* (blackthorn)	Apl. 22	Apl. 19	Apl. 22	Apl. 15	Apl. 27	Apl. 26	Apl. 13	Apl. 21	Mar. 25
28.	*Spiræa Ulmaria* (meadow sweet)	.....	.....	July 3	June 12	.....	.....	June 24	.....	June 15
29.	*Potentilla anserina* (silver-weed)	May 26	.....	May 27	May 28	.....	May 29	May 29	May 23	May 16
30.	*Rosa canina* (dog rose)	June 6	June 21	June 8	June 10	June 13	June 6	June 6	.....	June 3
31.	*Sorbus Aucuparia* (mountain ash)	May 17	.....	May 30	.....	.....	.....	May 19	.....	May 18
32.	*Cratægus Oxyacantha* (hawthorn)	May 17	May 24	May 24	May 19	.....	May 22	May 19	.....	May 12
33.	*Epilobium hirsutum* (hair willow-herb)	July 17	.....	.....	.....	.....	July 8	July 3	.....	July 5
34.	*E. montanum* (broad willow-herb)	.....	June 21	June 10	June 10	.....	June 21	.....	.....	June 11
35.	*Angelica silvestris* (wild angelica)	.....	.....	.....	.....	.....	.....	July 16	.....	July 28
36.	*Daucus Carota* (wild carrot)	July 1	.....	.....	.....	.....	.....	July 8	.....	July 2
37.	*Hedera Helix* (ivy)	.....	Oct. 1	.....	.....	.....	.....	Sept. 30	.....	Sept. 19
38.	*Cornus sanguinea* (dog wood)	.....	June 23	.....	.....	.....	.....	.....	.....	June 16

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39.	*Syringa vulgaris* (lilac)	May 20	.....	May 20	May 11	.....	May 22	May 9	.....	.....	May 7
40.	*Galium Aparine* (cleavers)	May 15	June 1	May 25	.....	.....	May 20	May 19	May 23	May 15	
41.	*G. verum* (yellow bedstraw)	.....	.....	July 2	.....	.....	.....	June 30	July 10	June 29	
42.	*Dipsacus silvestris* (wild teasel)	July 21	.....	.....	.....	.....	.....	July 25	.....	July 26	
43.	*Succisa pratensis* (devil's bit)	July 28	.....	.....	.....	.....	.....	July 16	.....	July 25	
44.	*Petasites officinalis* (butter-burr)	Apl. 3	.....	.....	Apl. 1	.....	.....	.....	.....	Mar. 20	
45.	*Tussilago Farfara* (coltsfoot)	Mar. 18	Mar. 23	Mar. 20	.....	Apl. 6	.....	Mar. 21	Mar. 21	Feb. 25	
46.	*Achillea Millefolium* (milfoil)	June 25	July 8	June 21	June 15	.....	July 1	June 29	.....	June 21	
47.	*Leucanthemum vulgare* (ox-eye)	May 26	June 8	May 26	June 1	May 31	May 29	May 23	.....	May 18	
48.	*Artemisia vulgaris* (mugwort)	July 20	Aug. 14	.....	.....	.....	.....	.....	.....	July 30	
49.	*Senecio Jacobæa* (ragwort)	.....	.....	June 19	June 28	.....	.....	July 10	.....	June 28	
50.	*Centaurea nigra* (black knapweed)	June 18	July 8	July 1	June 14	.....	July 8	June 19	.....	June 17	
51.	*Cirsium lanceolatum* (spear thistle)	.....	.....	July 1	.....	.....	.....	July 13	.....	June 19	
52.	*C. arvense* (field thistle)	.....	.....	July 7	July 7	.....	.....	July 6	.....	June 19	
53.	*Sonchus arvensis* (corn sow-thistle)	.....	July 1	.....	.....	.....	.....	.....	.....	July 7	
54.	*Hieracium Pilosella* (mouse-ear)	.....	May 30	June 5	.....	.....	.....	May 31	....	May 16	
55.	*Campanula rotundifolia* (hair-bell)	June 25	.....	June 20	.....	.....	.....	June 29	.....	July 7	
56.	*Ligustrum vulgare* (privet)	.....	.....	June 22	.....	.....	.....	June 14	.....	June 17	
57.	*Convolvulus sepium* (greater bindweed)	July 1	.....	July 9	.....	July 8	June 29	July 4	.....	July 1	
58.	*Symphytum officinale* (comfrey)	May 10	June 1	.....	.....	May 26	.....	May 29	.....	May 7	
59.	*Pedicularis silvatica* (red rattle)	.....	.....	.....	June 4	.....	.....	.....	.....	May 14	
60	*Veronica Chamædrys* (speedwell)	May 4	.....	May 6	Apl. 25	.....	.....	May 7	Apl. 28	Apl. 21	
61.	*Mentha aquatica* (water mint)	.....	.....	.....	.....	.....	.....	Aug. 4	.....	July 29	
62.	*Thymus Serpyllum* (wild thyme)	.....	.....	July 7	June 15	.....	.....	June 5	.....	June 8	
63.	*Prunella vulgaris* (self-heal)	.....	.....	June 22	June 24	.....	.....	.....	.....	June 19	
64.	*Glechoma hederacea* (ground-ivy)	Apl. 26	May 21	Apl. 24	Apl. 12	Apl. 21	Apl. 22	Apl. 19	Apl. 16	Mar. 26	
65.	*Galeopsis tetrahit* (hemp-nettle)	July 10	.....	.....	.....	.....	.....	.....	.....	June 30	
66.	*Stachys silvatica* (hedge woundwort)	June 14	.....	June 10	June 16	.....	.....	June 14	.....	June 6	
67.	*Ajuga reptans* (bugle)	.....	May 21	May 23	May 11	.....	May 22	May 20	.....	May 3	
68.	*Primula veris* (cowslip)	Apl. 16	Apl. 25	Mar. 31	Apl. 12	Apl. 6	Apl. 12	Apl. 2	Apl 12	Mar. 19	
69.	*Plantago lanceolata* (ribwort plantain)	May 1	.....	May 7	May 2	.....	May 18	May 7	Apl. 28	Apl. 20	
70.	*Mercurialis perennis* (dog's mercury)	Apl. 3	.....	Mar. 25	Mar. 29	Mar. 24	.....	Mar. 30	.....	Feb. 17	
71.	*Ulmus montana* (wych elm)	.....	.....	Mar. 26	Mar. 29	.....	.....	Apl. 2	.....	Mar. 2	
72.	*Salix Caprea* (great sallow)	Apl. 1	.....	Apl. 4	Apl. 1	Apl. 5	.....	Mar. 30	Apl. 3	Mar. 8	
73.	*Fagus silvatica* (beech)	.....	May 21	.....	.....	.....	.....	.....	.....	May 14	
74.	*Corylus Avellana* (hazel)	Feb. 1	Feb. 4	Feb. 17	.....	Feb. 28	.....	.....	.....	Jan. 26	
75.	*Orchis maculata* (spotted orchis)	.....	.....	June 17	June 3	.....	.....	.....	.....	June 3	
76.	*Iris Pseudacorus* (yellow iris)	.....	June 30	June 20	June 17	June 4	.....	June 10	.....	June 3	
77.	*Narcissus Pseudo-narcissus* (daffodil)	Mar. 31	.....	Apl. 1	Mar. 30	.....	Mar. 21	Mar. 29	Mar. 29	Mar. 6	
78.	*Galanthus nivalis* (snowdrop)	Feb. 1	Feb. 20	Jan. 27	Feb. 6	Feb. 1	Feb. 3	.....	Feb. 2	Jan. 22	
79.	*Scilla nutans* (blue-bell)	Apl. 26	.....	Apl. 28	Mar. 1	.....	.....	Apl. 30	.....	Apl. 14	

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DATES OF FLOWERING OF PLANTS OBSERVED IN 1886, WITH THE MEAN DATE FOR 1876–86.

No.	SPECIES.	WATFORD 1.	WATFORD 2.	HARPENDEN.	HERTFORD.	WARE.	HIGH WYCH.	HITCHIN.	ODSEY.	MEAN.
1.	*Anemone nemorosa* (wood anemone)	Apl. 3	.....	Apl. 3	Apl. 1	Apl. 12	.....	Mar. 30	.....	Mar. 13
2.	*Ficaria verna* (lesser celandine)	Mar. 21	Apl. 1	Mar. 26	.....	Mar. 24	Mar. 30	Mar. 21	.....	Feb. 21
3.	*Ranunculus acris* (upright crowfoot)	.....	May 21	Apl. 30	.....	.....	.....	May 28	.....	Apl. 23
4.	*Caltha palustris* (marsh marigold)	Apl. 21	Apl. 23	Apl. 18	Apl. 20	Apl. 19	Apl. 23	.....	.....	Mar. 24
5.	*Papaver Rhœas* (red poppy).....	June 4	June 8	June 8	June 2	June 2	.....	.....	.....	May 29
6.	*Nasturtium officinale* (water-cress).....	.....	July 1	.....	.....	.....	.....	June 14	.....	June 5
7.	*Cardamine pratensis* (cuckoo-flower)	.....	May 24	Apl. 30	Apl. 21	.....	.....	Apl. 24	.....	Apl. 13
8.	*Alliaria officinalis* (garlic-mustard).....	Apl. 22	.....	May 2	Apl. 20	.....	.....	Apl. 26	.....	Apl. 14
9.	*Draba verna* (whitlow grass)	Apl. 1	.....	Mar. 31	Apl. 4	.....	.....	Mar. 29	.....	Mar. 9
10.	*Viola odorata* (sweet violet).....	Apl. 3	Apl. 12	Mar. 24	Apl. 2	.....	Mar. 30	Mar. 27	Apl. 2	Feb. 13
11.	*Polygala vulgaris* (milkwort)	June 2	.....	May 31	June 7	.....	.....	May 22	May 23	May 8
12.	*Lychnis Flos-cuculi* (ragged Robin).....	June 2	June 1	June 1	June 4	.....	.....	May 28	.....	May 24
13.	*Stellaria Holostea* (greater stitchwort)	Apl. 15	.....	Apl. 25	Apl. 14	Apl. 28	Apl. 14	Apl. 22	.....	Apl. 5
14.	*Malva silvestris* (common mallow).....	June 14	July 1	.....	June 17	June 16	.....	.....	.....	June 6
15.	*Hypericum quadratum*(squareSt J.w.)	.....	.....	.....	.....	.....	.....	July 27	.....	July 5
16.	*H. pulchrum* (upright St. John's wort)	.....	Aug. 1	July 3	...	.....	.....	July 15	.....	June 28
17.	*Geranium Robertianum* (herb Robert)	May 13	May 21	May 9	.....	.....	May 8	May 15	.....	Apl. 26
18.	*Euonymus europæus* (spindle-tree) ...	.....	....	June 9	June 8	.....	.....	June 18	.....	June 1
19.	*Acer Pseudo-platanus* (sycamore)	.....	.....	May 7	May 4	.....	May 5	May 10	.....	Apl. 28
20.	*Æsculus Hippocastanum* (h. chestnut)	May 20	.....	May 21	.....	.....	May 16	May 9	.....	May 5
21.	*Cytisus Laburnum* (laburnum).....	May 18	.....	May 25	May 14	.....	.....	May 16	.....	May 15
22.	*Trifolium repens* (Dutch clover).....	May 15	.....	June 6	May 16	June 3	.....	May 30	.....	May 17
23.	*Lotus corniculatus* (bird's foot trefoil)	June 2	May 28	June 8	June 1	.....	May 29	May 30	.....	May 20
24.	*Vicia Cracca* (tufted vetch)	.....	July 1	July 2	.....	.....	.....	June 24	.....	June 24
25.	*V. sepium* (bush vetch)	.....	.....	May 8	May 17	.....	.....	May 31	.....	Apl. 27
26.	*Lathyrus pratensis*(meadow vetchling)	.....	.....	June 9	June 5	June 16	June 8	June 15	.....	June 3
27.	*Prunus spinosa* (blackthorn)	Apl. 22	Apl. 19	Apl. 22	Apl. 15	Apl. 27	Apl. 26	Apl. 13	Apl. 21	Mar. 25
28.	*Spiræa Ulmaria* (meadow sweet)	.....	.....	July 3	June 12	.....	.....	June 24	.....	June 15
29.	*Potentilla anserina* (silver-weed).....	May 26	.....	May 27	May 28	.....	May 29	May 29	May 23	May 16
30.	*Rosa canina* (dog rose).....	June 6	June 21	June 8	June 10	June 13	June 6	June 6	.....	June 3
31.	*Sorbus Aucuparia* (mountain ash) ...	May 17	.....	May 30	.....	.....	.....	May 19	.....	May 18
32.	*Cratægus Oxyacantha* (hawthorn)	May 17	May 24	May 24	May 19	.....	May 22	May 19	.....	May 12
33.	*Epilobium hirsutum* (hair willow-herb)	July 17	.....	.....	.....	.....	July 8	July 3	.....	July 5
34.	*E. montanum* (broad willow-herb)	.....	June 21	June 10	June 10	.....	June 21	.....	.....	June 11
35.	*Angelica silvestris* (wild angelica)	.....	.....	.....	.....	.....	.....	July 16	.....	July 28
36.	*Daucus Carota* (wild carrot).....	July 1	.....	.....	.....	.....	.....	July 8	.....	July 2
37.	*Hedera Helix* (ivy)	.....	Oct. 1	.....	.....	.....	.....	Sept. 30	.....	Sept. 19
38.	*Cornus sanguinea* (dog-wood)	.....	June 23	.....	.....	.....	.....	.....	.....	June 16

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39.	*Syringa vulgaris* (lilac)	May 20	.....	May 20	May 11	.....	May 22	May 9	.....	May 7
40.	*Galium Aparine* (cleavers)	May 15	June 1	May 25	.....	.....	May 20	May 19	May 23	May 15
41.	*G. verum* (yellow bedstraw)	.....	.....	July 2	.....	.....	.....	June 30	July 10	June 29
42.	*Dipsacus silvestris* (wild teasel)	July 21	.....	.....	.....	.....	.....	July 25	.....	July 26
43.	*Succisa pratensis* (devil's bit)	July 28	.....	.....	.....	.....	.....	July 16	.....	July 25
44.	*Petasites officinalis* (butter-burr)	Apl. 3	.....	.....	Apl. 1	.....	.....	.....	.....	Mar. 20
45.	*Tussilago Farfara* (coltsfoot)	Mar. 18	Mar. 23	Mar. 20	.....	Apl. 6	.....	Mar. 21	Mar. 21	Feb. 25
46.	*Achillea Millefolium* (milfoil)	June 25	July 8	June 21	June 15	.....	July 1	June 29	.....	June 21
47.	*Leucanthemum vulgare* (ox-eye)	May 26	June 8	May 26	June 1	May 31	May 29	May 23	.....	May 18
48.	*Artemisia vulgaris* (mugwort)	July 20	Aug. 14	.....	.....	.....	.....	.....	.....	July 30
49.	*Senecio Jacobæa* (ragwort)	.....	.....	June 19	June 28	.....	.....	July 10	.....	June 28
50.	*Centaurea nigra* (black knapweed)	June 18	July 8	July 1	June 14	.....	July 8	June 19	.....	June 17
51.	*Cirsium lanceolatum* (spear thistle)	.....	.....	July 1	.....	.....	.....	July 13	.....	June 19
52.	*C. arvense* (field thistle)	.....	.....	July 7	July 7	.....	.....	July 6	.....	June 19
53.	*Sonchus arvensis* (corn sow-thistle)	.....	July 1	.....	.....	.....	.....	.....	.....	July 7
54.	*Hieracium Pilosella* (mouse-ear)	.....	May 30	June 5	.....	.....	.....	May 31	.....	May 16
55.	*Campanula rotundifolia* (hair-bell)	June 25	.....	June 20	.....	.....	.....	June 29	.....	July 7
56.	*Ligustrum vulgare* (privet)	.....	.....	June 22	.....	.....	.....	June 14	.....	June 17
57.	*Convolvulus sepium* (greater bindweed)	July 1	.....	July 9	.....	July 8	June 29	July 4	.....	July 1
58.	*Symphytum officinale* (comfrey)	May 10	June 1	.....	.....	May 26	.....	May 29	.....	May 7
59.	*Pedicularis silvatica* (red rattle)	.....	.....	.....	June 4	.....	.....	.....	.....	May 14
60	*Veronica Chamædrys* (speedwell)	May 4	.....	May 6	Apl. 25	.....	.....	May 7	Apl. 28	Apl. 21
61.	*Mentha aquatica* (water mint)	.....	.....	.....	.....	.....	.....	Aug. 4	.....	July 29
62.	*Thymus Serpyllum* (wild thyme)	.....	.....	July 7	June 15	.....	.....	June 5	.....	June 8
63.	*Prunella vulgaris* (self-heal)	.....	.....	June 22	June 24	.....	.....	.....	.....	June 19
64.	*Glechoma hederacea* (ground-ivy)	Apl. 26	May 21	Apl. 24	Apl. 12	Apl. 21	Apl. 22	Apl. 19	Apl. 16	Mar. 26
65.	*Galeopsis tetrahit* (hemp-nettle)	July 10	.....	.....	.....	.....	.....	.....	.....	June 30
66.	*Stachys silvatica* (hedge woundwort)	June 14	.....	June 10	June 16	.....	.....	June 14	.....	June 6
67.	*Ajuga reptans* (bugle)	.....	May 21	May 23	May 11	.....	May 22	May 20	.....	May 3
68.	*Primula veris* (cowslip)	Apl. 16	Apl. 25	Mar. 31	Apl. 12	Apl. 6	Apl. 12	Apl. 2	Apl 12	Mar. 19
69.	*Plantago lanceolata* (ribwort plantain)	May 1	.....	May 7	May 2	.....	May 18	May 7	Apl. 28	Apl. 20
70.	*Mercurialis perennis* (dog's mercury)	Apl. 3	.....	Mar. 25	Mar. 29	Mar. 24	.....	Mar. 30	.....	Feb. 17
71.	*Ulmus montana* (wych elm)	.....	.....	Mar. 26	Mar. 29	.....	.....	Apl. 2	.....	Mar. 2
72.	*Salix Caprea* (great sallow)	Apl. 1	.....	Apl. 4	Apl. 1	Apl. 5	.....	Mar. 30	Apl. 3	Mar. 8
73.	*Fagus silvatica* (beech)	.....	May 21	.....	.....	.....	.....	.....	.....	May 14
74.	*Corylus Avellana* (hazel)	Feb. 1	Feb. 4	Feb. 17	.....	Feb. 28	.....	.....	.....	Jan. 26
75.	*Orchis maculata* (spotted orchis)	.....	.....	June 17	June 3	.....	.....	.....	.....	June 3
76.	*Iris Pseudacorus* (yellow iris)	.....	June 30	June 20	June 17	June 4	.....	June 19	.....	June 3
77.	*Narcissus Pseudo-narcissus* (daffodil)	Mar. 31	.....	Apl. 1	Mar. 30	.....	Mar. 21	Mar. 29	Mar. 29	Mar. 6
78.	*Galanthus nivalis* (snowdrop)	Feb. 1	Feb. 20	Jan. 27	Feb. 6	Feb. 1	Feb. 3	.....	Feb. 2	Jan. 22
79.	*Scilla nutans* (blue-bell)	Apl. 26	.....	Apl. 28	Mar. 1	.....	.....	Apl. 30	.....	Apl. 14

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Earliest Dates of Observations of Insects, Birds, etc., in 1886, with the Mean Date for 1876-86.

No.	Phenomena.	1886.	Mean.
	Insects.		
80.	*Melolontha vulgaris* (cock-chafer) appears	May 28	May 27
81.	*Rhizotrogus solstitialis* (fern-chafer) ap.	June 10	June 12
82.	*Timarcha lævigata* (bloody-nosed beetle) ap.	Mar. 23	Apl. 9
83.	*Lampyris noctiluca* (glow-worm) ap.	.....	May 29
84.	*Apis mellifica* (honey-bee) ap.	Mar. 17	Jan. 30
85.	*Vespa vulgaris* (common wasp) ap.	Jan. 28	Mar. 16
86.	*Pieris Brassicæ* (large white butterfly) ap.	Mar. 28	Apl. 7
87.	*P. Rapæ* (small white butterfly) ap.	Apl. 5	Mar. 27
88.	*Anthocaris cardamines* (orange-tip butterfly) ap.	May 2	May 7
89.	*Epinephele Janira* (meadow-brown butterfly) ap.	June 2	May 28
90.	*Bibio Marci* (St. Mark's fly) ap.	Apl. 25	Apl. 27
	Birds.		
91.	*Strix Aluco* (brown-owl) hoots	Apl. 18	Apl. 10
92.	*Muscicapa grisola* (flycatcher) arrives	May 12	May 12
	——— nests	.....	May 30
	——— hatches	.....	June 30
	——— departs (last seen)	.....	Aug. 30
93.	*Turdus musicus* (song-thrush) sings	Jan. 7	Jan. 11
	——— nests	Apl. 1	Mar. 20
	——— hatches	Apl. 18	Apl. 9
94.	*T. Pilaris* (field-fare) arrives	Nov. 24	Oct. 24
	——— departs (last seen)	Mar. 2	.....
95.	*Daulias Luscinia* (nightingale) sings	Apl. 5	Apl. 14
96.	*Saxicola Œnanthe* (wheatear) arrives	Mar. 22	Mar. 13
97.	*Phylloscopus Trochilus* (willow-wren) sings	Mar. 24	Mar. 25
98.	*P. collybita* (chiff-chaff) sings	Mar. 23	Mar. 23
99.	*Alauda arvensis* (sky-lark) sg.	Jan. 30	Jan. 18
100.	*Fringilla cœlebs* (chaffinch) sg.	.....	Feb. 4
101.	*Corvus frugilegus* (rook) builds	Mar. 4	Feb. 21
	——— hatches	Apl. 19	Apl. 12
102.	*Cuculus canorus* (cuckoo) calls	Apl. 13	Apl. 10
	——— changes its note	.....	May 30
103.	*Hirundo rustica* (swallow) arrives	Apl. 1	Apl. 10
	——— flocks	.....	Aug. 7
	——— departs (last seen)	Oct. 10	Oct. 24
104.	*H. urbica* (house-martin) arrives	Apl. 22	Apl. 17
105.	*H. riparia* (sand-martin) arr.	Apl. 4	Apl. 16
106.	*Cypselus Apus* (swift) arr.	May 6	May 5
	——— departs (last seen)	.....	Sept. 7
107.	*Caprimulgus europæus* (goatsucker) arrives	.....	.....
108.	*Turtur communis* (turtle-dove) coos	May 3	May 3
109.	*Perdix cinerea* (partridge) pairs	.....	Jan. 24
	——— hatches	.....	June 15
110.	*Scolopax Rusticola* (woodcock) arrives	Oct. 23	Oct. 14
111.	*Crex pratensis* (corn-crake) arr.	Apl. 25	Apl. 24
	Amphibian.		
112.	*Rana temporaria* (common frog) spawns	Mar. 21	Mar. 10

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late; and of the last 20, from 6th June to 25th July, 0·6 early; showing that, to a much greater extent even than in 1885, a very similar year, vegetation was much the most backward in the early spring, not one-third as backward towards the end of spring, and slightly forward in the early part of summer.

Taking each 10 species in succession, there is a very decided difference in the state of backwardness in the first three groups, rapidly lessening from one group to the other; the change, which throughout is in the same direction, not being quite so great from the third to the fourth group, still less from that to the fifth, and again increasing from that to the sixth. The average for February (22nd Jan. to 9th March) is 20·9 days late; for March (13th March to 20th April) 13·9; for April (21st April to 15th May) 7·6; for May (16th May to 3rd June) 3·9; for June (5th to 21st) 2·4; and for July (24th June to 25th July) 3·7 days early.

Of the first 10 species the 2 flowering in January averaged 6·5 days late, the 4 in February 28·7 days late, and the 4 in March 20·3 days late. January was cold and February was still colder, having a mean temperature but one degree above freezing. The extreme lateness of vegetation in February and the early part of March is thus fully accounted for. Our Harpenden observer says that there in February "vegetation was exceedingly dormant; although the weather during the first week was fair, yet the remainder of the month was so gloomy and foggy, with severe frosts, and so little bright sunshine, that under many of the hedges in the neighbourhood, snow, which fell on the 6th of January, was to be seen unmelted at the end of February." Not one of the four species which usually flower in February came out within that month; and of these the lesser celandine (2) was a month late, and the sweet violet (10) and dog's mercury (70) were between five and six weeks late.

Of the second group of 10 species the 6 usually flowering in March were 17·0 days late, and the 4 flowering in April were 9·2 days late. March was a very cold month, and very dull and humid, but the cold was not so exceptional as in February. The result appears in a slightly lesser backwardness of vegetation in the last fortnight of March and a considerably lesser backwardness in the first fortnight of April. Four of the six March species this year flowered in April, and the other two on the 30th and 31st of March respectively.

Of the third group the 4 species which flower within the month of April averaged 8·5 days late, and the 6 which flower in May averaged 7·2 days late. April had about an average mean temperature, but the effect of the previous cold weather is still apparent in the backward state of vegetation. At Harpenden our observer states that "on the 1st of May vegetation was about as advanced as it ordinarily is in the first week of April. It is true," he adds, "the swallow was seen at Harpenden on the 18th of April and the nightingale on the 25th, other spring birds arriving not more than a week late; but a better index than

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these summer visitors is to be found in the spring flowers, and these have not been so backward on May-day for a great number of years."

Of the fourth group the 6 species which usually flower in the last fortnight of May averaged 7·2 days late, exactly the same as the 6 which flower in the first fortnight of this month, and the 4 which usually flower within the first three days of June averaged 1·5 days late. In May as in April the temperature was about the average, but May was a very wet month, and it is probably owing to this that no great change for the better is apparent until the beginning of June, when for the first time in the year vegetation is seen to be about in its normal state.

Of the fifth group of 10 species, all of which come into flower in the month of June, the first 5 averaged 1·0 day late and the last 5 averaged 3·8 days late. This latter result is owing chiefly to the lateness of one species, the field thistle (52), and therefore it probably does not fairly represent the general state of vegetation. The earlier part of the month of June was cold, the last week only being warm and nearly bringing the temperature of the whole month to the average. It was a very dry month. At Harpenden wheat was in ear on the 16th and the cereal crops were quite a fortnight later than in average seasons.

Of the sixth and last group the first 5 species which usually flower in June averaged 1·4 days late, and the last 5 which flower in July averaged 8·8 days early. Every one of these came out before the usual time, and the hair-bell (55) was particularly early in flowering. The fine warm weather of the last week in June, which was prolonged for some time into July, doubtless induced this result.

From July to about the middle of November the weather continued warm, and excepting in October but little rain fell. The ivy (37), the only species remaining which has been observed for at least nine years, was, however, a week later than usual in coming into flower.

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XX.

THE HESSIAN FLY.

By F. Maule Campbell, F.L.S., F.Z.S., F.R.M.S., F.E.S., President.

Read at Hertford, 24th May, 1887.

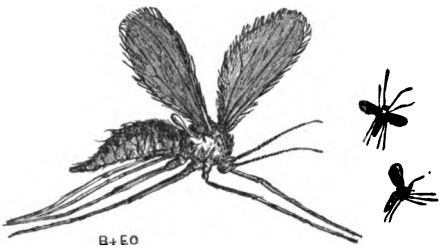

Fig. 1. Cecidomyia destructor, *Say* (Hessian Fly). Enlarged and natural size.

The occurrences which led to the recognition of the presence of this pest in Great Britain were as follows. In July, 1886, Mr. Palmer, of Revell's Hall, Hertford, noticed that his barley plants were unusually "root-fallen." On examination he found that the cause was not "gout" (a popular term for the distortions and swellings in the joints of the stems of corn attacked by the ribbon-footed corn-fly, *Chlorops tæmopus*, Curtis), and that the stems had given way just above the second joint from the root of the plant. On removing the sheath he observed some small brown objects of a certain linear form packed close to this second joint, and in the direction of the axis of the plant. These were sent on the 27th of July to Miss E. A. Ormerod, who lost no time in visiting the fields, reporting that they were pupæ, and as she believed those of the Hessian fly, or *Cecidomyia destructor*, Say, in consequence of their resemblance to the seed of linseed, which the pupæ of this insect are so like that they are called "flax-seeds" in America and Canada. "On the 8th of September" (to use Miss Ormerod's own words) "the first fly was developed from my 'flax-seeds,' or puparia. This to the naked eye was a stout-made little brown gnat, with darker head and body, legs of a rather lighter brown, brown horns, and a pair of smoky grey wings with longitudinal veins. It was exactly one-eighth of an inch in length."* Miss Ormerod, after minute examination, had no doubt that her surmise as to the species was correct, and this opinion was confirmed by other entomologists. Meanwhile, puparia were received from Romford, Ware, Inverness, and Crieff, and the attack was identified on two more farms at Hertford, two farms at Hitchin, and one near Luton. It is difficult, however, to believe that the Hessian fly is confined to these localities, and the extent of its distribution can only be ascertained after agriculturists have been enabled to recognize the appearance of an attacked plant. Indeed, there is some reason to think that the pest had for two or three years infested the crops of Revell's Hall Farm,

* 'The Hessian Fly,' by Miss Ormerod, p. ii.

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for Mr. Palmer, senior, informs me that he had noticed during the last three seasons that his barley was more "root-fallen" than might be expected, and it was this appearance which ultimately led to the discovery of the real cause.

The dissemination of information amongst farmers and agricultural labourers as to the character of the attack is the initial step towards the adoption of precautionary measures, and it is somewhat amusing to an entomologist to find that, in accordance with their instructions, the veterinary inspectors were making inquiries in the dark of farmers last September whether the Hessian fly had been found in their district, before either the inspectors themselves or the farmers knew the indications of its presence or what to look for. The United Kingdom enjoys considerable immunity from the ravages of insect pests as compared with most other countries, and this may account for the inaptitude of the Privy Council when laudably endeavouring to defend agricultural interests from such attacks. Thus, in 1877, when it was believed that the crop of potatoes was endangered by the arrival of Colorado beetles at Liverpool on a cattle boat from Texas, it was ordered that any one finding such an insect must, under a penalty, give notice "with all practicable speed" to a "constable of the locality."

Distribution.

The first chronicled serious ravages of this fly occurred in America in the year 1779, when, according to Dr. Asa Fitch,* "the crops of wheat were severely injured or wholly destroyed by it in Kings and Richmond Counties." The same author considers that the fly is not indigenous to his country, and that it was introduced, probably with the straw used in packing, by the British reinforcement of 12,000 Hessian troops who landed in August, 1776, on Staten and the west end of Long Island. This theory has, however, been shown by Wagner† to be untenable, as being opposed to the developmental history of the insect. Further, Hagen‡ states that the old Minutes of the American Philosophical Society, which were in 1885 in course of publication, contain two papers read in 1768 on the damage done to wheat by the Hessian fly, and the Secretary of the Society wrote to Hagen on the 1st of April, 1884: "The term came into use in Pennsylvania from the early German emigrants long before the revolution. I am sure the term occurs in Pennsylvania gazettes long prior to that period."

The appearance of the Hessian fly on Long Island evidently was but accidentally contemporaneous with that of the Hessian troops. It was not exceptional about the time of the American revolution for each party to attach by way of opprobrium the name of their opponents to an injurious insect. Thus, the friends of the British Government in Maryland spoke of a "Revolution Fly," and it is

* 'The Hessian Fly,' 1847, p. 12.

† 'Untersuchungen über die neue Getreidegallmücke,' B. Wagner, p. 25. A translation of this paper is in the appendix to 3rd Report U. S. Entomological Commission.

‡ 'Canadian Entomologist,' vol. xvii, p. 84.

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quite possible that the agriculturists of Long Island, enlarging upon an already established term, nicknamed their winged enemy the "Hessian Fly" to flout the Hessian troops, against whom they had a strong animosity.

In the seed time of 1787 the flies were seen like a cloud coming over the Delaware River, while during the following harvest they entered rooms in Pennsylvania in such numbers as to be exceedingly troublesome. The appalling and increasing havoc of the fly excited the attention of the British Government, and, after consultation with Sir Joseph Banks, an order was issued on the 25th of June, 1788, prohibiting the entry of wheat from the United States into the United Kingdom, although it was still allowed to be stored at the different seaports. A few months afterwards our Government bought the grain thus stored, kiln-dried it, and sold it at a loss.

Since 1779 the fly has made steady and rapid progress, and it may now be said to infest the whole wheat area of the United States and the adjoining parts of Canada.* Its ravages appear to be the greatest in the Central States, and in some localities the whole of the crop has been destroyed. In 1846 the loss of wheat from this insect in the western section of the State of New York was estimated at not less than 500,000 bushels.

Mr. A. S. Packard, junior, in the third report of the United States Entomological Commission, points out that during the last 90 years there have been five periods marked by an unusual number of Hessian flies, namely, about the years 1790, 1817, 1844-1845, 1871-1872, and 1876-1878, and that after the culmination of the greatest abundance they often suddenly disappear. This is not unusual with insects, many of which are very dependent on favourable seasons, but Mr. Packard considers that in this case it is due to the numbers of parasites, to which I will refer hereafter.†

The first reliable evidence as to this pest in Europe was given by Dana, who in 1834 discovered it near Toulon, Naples, and near Malon, on the island of Minorca.‡ In 1857 and 1858 it was met with in the provinces of Silesia and Posen, and in Prussia, where it was considered to be a new corn-fly, and was described by Loew§ as a new species, *Cecidomyia secalina*. This error was pointed out by Wagner,‖ who chronicled the occurrence in 1860 of the pest in Fulda (Hesse Cassel). It is now well known in Germany, Austria, Hungary, France, Italy, Russia, and Sweden. It is, however, satisfactory to find from the report on the Hessian fly issued by our agricultural department (1886) that this insect has not been at any time very troublesome in Europe, except in Germany and Austria in 1863 and 1864, and has there hardly been noticed during the last 20 years as seriously injurious to crops.

* It appears that there is "very little of it now in Canada." See 'Report on the Hessian Fly,' 1886, by Charles Whitehead.

† 'Third Report of the U. S. Entomological Commission,' p. 231.

‡ 'Silliman's Journal,' vol. xli, p. 154.

§ 'Die neue Kornmade und die Mittel welche gegen sie anzuwenden sind,' H. Loew, 1859. ‖ 'Untersuchungen über die neue Getreidegallmücke.'

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Description.

The Hessian fly was first scientifically described by Say in 1817,* who gave it the name of *Cecidomyia destructor*. The genus *Cecidomyia* belongs to the family Cecidomyidæ, which is a large Dipterous group. The eggs of most of the species are laid *in* the stems, leaves, buds, etc., of plants, and the irritation thus caused produces galls. In the case of the Hessian fly the eggs are laid *on* the leaf, and do not give rise to galls.

The egg † "is about $\frac{1}{100}$th of an inch long, cylindrical, pointed at each end, the shell shining and transparent, the egg being of a pale red colour when the embryo is nearly developed."

The larva.—"The body is soft, smooth, shining, oval-cylindrical, beneath a little flattened, and consists of twelve segments besides the head, the latter soft, fleshy, and but slightly separated from the body, with very rudimentary mouth-parts (jaws, etc.). The rings or segments are moderately convex and tolerably distinct from each other; the sutures between the segments in the living larva being indicated by faint transverse lines of a greenish-brown hue, according to Fitch, who also states that the mature larva, freshly taken from the roots of the wheat, measures about 0·15 of an inch in length by 0·06 of an inch in width."

According to Lindeman,‡ the larva on leaving the egg has on the first segment two symmetrical colourless hooks (Haaken), which point outwards, and between them in the middle of the head is a semicircular chitinous plate, while the last segment bears two bristles. Unfortunately I have not met with this first stage. The plate, hooks, and bristles are removed and shed with the skin, after which the larva has the appearance just described.

In common with other larvæ of the Cecidomyidæ there is an "anchor-process" or "breastbone" upon the under surface of the second segment, the use of which may be to bruise the stem of the plant on which it is feeding. This process varies in different species as shown in the Fig. 2, but I am not aware that it occurs in the first larval stage of *C. destructor*.

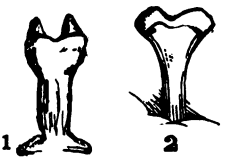

Fig. 2. (1) Process of *C. destructor*. (2) Process of *C. tritici*.

The puparium is somewhat larger than the larva, of a rude spindle-shaped form, and of a bright chestnut colour. When the

* 'Journal of the Philadelphian Academy of Sciences,' vol. i, p. 45.

† The passages within marks of quotation in the descriptions of egg, larva, male, and female, are from Packard's 'Third Report of the U. S. Entomological Commission,' p. 207, and *infra*.

‡ "Die Hessenfliege in Russland," 'Bull. Soc. Imp. de Moscou,' 1887, p. 402.

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puparium is newly formed, the transverse lines showing the divisions of the segments of the larva are easily observable. As it grows older, these transverse lines almost entirely disappear, and it becomes marked with longitudinal lines and depressions.

*The female.**—"The body is rather slender, uniformly dark brown, the head is round but somewhat flattened, the eyes are black, the wings uniformly dull smoky brown, while the legs are paler brown than the rest of the upper side of the body.

"The body, wings, and legs are provided with fine hair-like scales, those on the wings being in many cases quite broad and ribbed, somewhat like the scales on the wings of a butterfly or moth. The pale brown antennæ are about half as long as the body, the joints are very distinct, like a string of beads, each one being oval-cylindrical. There are seventeen joints,† the two basal ones being large, nearly globular, flattened lengthwise, and nearly half as long as thick, and each of nearly equal size; joints 3–5 are longer than the remaining ones, and are slightly contracted in the middle; the remaining 6–17 gradually increase in length, each joint being provided with about ten hairs, arranged in a rude whorl; the terminal joint is long and conical. The legs are of the same colour as the under side of the body, being a little paler than the back. The abdomen is rather full, with nine well-marked rings or segments, the paler small ovipositor forming the tenth. The latter is one-half as thick as the ninth segment, and about two-thirds or quite as long; is slightly sinuous, and a little smaller at the end than at the base. The wings are dusky, with a fine fringe around the edge, and there are three veins. The subcostal vein ends near the outer third of the wing; the median vein arises from near the base of the submedian vein and runs nearly parallel to the subcostal vein, while a branch (its base disconnected with the main vein) extends along the middle of the wing; the submedian vein is well developed, at the base throwing off the median vein at a little distance from the base of the wing, and losing itself before turning down to the edge of the wing. The length of the fly is 2·5 millimetres, or about one line, *i.e.* $\frac{1}{11}$th of an inch."

The male.—"The male is rather smaller than the female, being distinguished by the long, slender abdomen, and the longer and more hairy antennæ. The joints of the latter are twenty in number,‡ oval, the terminal one conical, and all provided with a few hairs, much longer than those of the female, and arranged in a decidedly verticillate manner. The abdomen in the living specimen is black or brownish black, with bands at the sutures both above and beneath, of a brick red, tawny yellow, or greyish colour, varying in their width as this part of the body is more or less distended" The claspers at the end of the body are stout, much more so than in *Cecidomyia leguminicola* of the clover.

* See the 'Entomologist,' p. 170, July, 1867, for descriptions by Dr. H. R. Meade of female and male from English specimens.

† The number varies from 16 to 18.

‡ The number varies from 17 to 20.

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Life-History.

The general life-history of the Hessian fly in the United Kingdom does not differ from that observed in other parts of Europe and in America. There are two broods—one is due in spring, and the second in autumn. The first lays eggs late in April or May, some of which develope into perfect insects by August or September, whilst others are retarded until the following spring, as I show later on. The eggs in spring are laid on wheat, barley, or rye, in the grooves of the upper surface of the leaves growing above the first, second, or third joint of the stalk. *Oats are not attacked.* The female appears careful in the selection of plants on which to lay her eggs, giving preference to those which are not too far advanced, and Mr. Palmer informs me that though his barley was infested, yet his wheat was almost free. This may be explained by the barley in that season being less forward than wheat, and therefore offering to the parent a more suitable plant for rearing its offspring. In the act of oviposition the fly stands with her head towards the point of the leaf, and in less than half a minute lays two or three eggs; she visits leaf after leaf until she has parted with about eighty eggs. The number found on each leaf varies from one to thirty or more. The larvæ hatch out in four days in warm weather; making their way very slowly down the leaf, they enter the sheath, and proceed to the joint below, where they cast their skins (according to Lindeman), and undergo their other developmental changes.* They do not burrow into nor gnaw the stalk, for their mouth-organs are far too weak for this. With the aid possibly of their anchor-process, they bruise the stalk and remain lengthwise living upon the sap. In four or five weeks, varying with the season, the larvæ begin to turn brown, and then take a chestnut colour, when they look like flax-seeds. The growing plant presses them firmly on all sides, and the irregularities of the stalk and sheath produce the longitudinal lines and depressions referred to (p. 184) in the description of the puparium. The pupal stage is however not yet reached. The body having slightly contracted, has separated from the external skin, which has now no vital function, and only acts as a protective covering. Thus sealed in, the larvæ cannot feed, and remain dormant for a varying period until they enter the pupal stage.† Meanwhile the ear of the plant is ripening, and the injured stalk, too weak to bear the weight, bends over just above the joint where the larvæ are situated, as shown at A in Fig. 3.

The appearance is characteristic. The duration of the pupal stage has been observed by B. Wagner (*op. cit.*) to extend from 12 to 14 days. The time for the full development of the imago having arrived, the insect breaks its chestnut-coloured outer protective covering, or puparium, by bending the body, and works its way

* I have found the puparia in a few cases attached to the sheath some distance from a joint.

† Such a pupa is termed coarctate, *i.e.* protected by the skin of the larva.

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upward between the sheath and the now bent stalk. Coming to a cleft, it passes into the free air, and, partly sustained by the straw contracting over the end of the abdomen, and partly by its legs, remains in a horizontal position until its thin real pupal membrane dries and cracks on the upper side of the thorax.* Then, protruding its head and thorax, it frees the limbs and body, and appears as a perfect insect, to continue its species and die. The preference of the female, while egg-laying, for leaves leading to the second joint of the plant, would appear to be due to the fact, that at the period her offspring are fully developed, the sheath which covers them has become loose of itself, and offers no obstruction to their release.

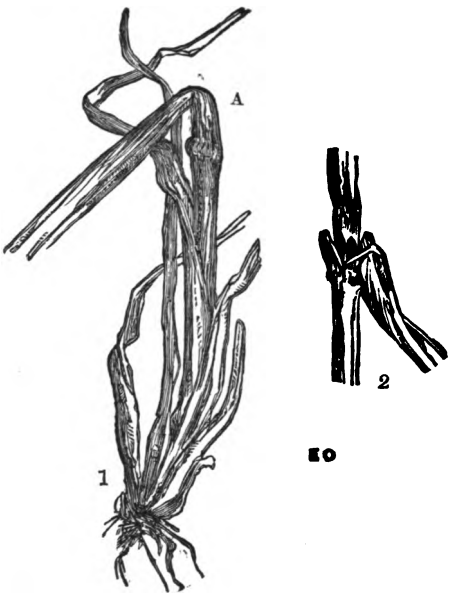

FIG. 3. (1) Barley plant injured by *C. destructor* and bent above the joint where the larva is situated. (2) Puparia of *C. destructor* in situ. The sheath of the plant has been removed.

The climate of America induces the early sowing of wheat, and by September the plant is sufficiently advanced to receive the eggs of the second or autumn brood, the development of which I have just described. The larvæ when hatched find their way downward to the upper part of the root, and there they obtain their nourishment.† The discoloured blade reveals its injury and soon

* I have not seen this, but summarize Fitch's remarks. See 'Noxious, Beneficial, and other Insects' (1865), p. 139. B. Wagner also describes the exit of the perfect insect, *op. cit.* p. 15.

† There may even be at this season self-sown barley or shoots from injured plants which are as advanced as in late spring, in which case the eggs are laid, as by the previous generation, in the leaves above the second joint.

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dies. By this time the larva is mature and passes into the dormant stage, in which it remains until the first days of spring, when, after turning into a pupa, it emerges as an imago. From a note in the 'American Naturalist' (vol. xviii, part 1, p. 195) it would appear that many puparia are destroyed by the winter, for the writer states that he has often dug up and examined roots during that season, and has found the larvæ dead and rotten.

In a country like ours the sowing of wheat is later than in America, and the perfect insects of the first, or April or May, brood, which breed in autumn, have passed away before the blades appear. But in clover fields, if not elsewhere, there is young growth from injured and self-sown plants of both wheat and barley which offer a brood-place, and Mr. Palmer has found the pupæ on self-sown barley in October. Further, it is said that in 1797, in America, Timothy-grass (*Phleum pratense*) was attacked. But Wagner's experiences in Fulda in Hesse* alone lead us to dismiss any consolation derived from a possible difficulty of the pest finding a suitable nidus for its eggs in September and October. In March, 1861, he examined a field of young clover sown in the autumn of 1859 with wheat, of which there remained nothing but the stubble. In this he not only found puparia, but also on the same plant empty cases from which the imago had emerged. Now, as already stated, the larvæ feed on the young plants, so that they could not have proceeded from eggs laid during the autumn of 1860. He collected some of the puparia and the flies hatched out between the 13th of April and the 12th of May. He sums up these observations as follows:—viz. that the eggs out of which are produced the larvæ hybernating on stubble are deposited in May, the perfect insects appear the following year in April and May, and the metamorphosis of these flies requires one year. This is in accordance with Harris,† who, in 1852, stated: "The transformation of some in each brood appears to be retarded beyond the usual time, as is found to be the case with many other insects, so that the life of these individuals, from the egg to the winged state, extends to a year or more in length." It is clear from the above, that the late period of sowing wheat in this country, as compared with that in America, does not prevent the propagation of the fly. My own experience leads me to think that most of the offspring of the first, or spring, brood do not appear as perfect insects until the following year.

The fact, however, that both empty and occupied puparia were found on the same plant under the circumstances mentioned by B. Wagner may possibly be otherwise explained than by protracted development. Nicholas Wagner‡ discovered that the larvæ of one

* 'Untersuchungen über die neue Getreidegallmucke,' Balthaser Wagner, Fulda, 1861, p. 17. A translation appears in the Appendix to the 'Third Report of the U. S. Entomological Commission,' of which see p. 21 and *infra*.

† 'A Treatise on some of the Insects of New England,' 2nd ed., p. 455.

‡ K. E. von Bae, "Bericht über eine neue von Prof. Wagner in Kasan an Dipteren beobachtete abweichende Propagationsform," 'Bull. Acad. St. Petersburg,' 1863, p. 239; and 'Zeitschrift wissenschaftliche Zoologie,' vol. xiii, p. 513.

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of the *Cecidomyiæ* were viviparous, and multiplied agamogenetically in autumn, winter, and spring. This was fully corroborated by Meinert,* Pagenstecher,† and Leuckart.‡ It seems that this process may extend largely amongst that genus, and should it occur with *C. destructor*, the hybernating larvæ found by B. Wagner may have been the descendants of the larvæ which proceeded from the eggs laid in the spring. H. Hagen thinks that the perfect insect may be capable of parthenogenetic reproduction, for one of this species, which was hatched out from a solitary pupa in a glass tube, laid about 100 eggs, and these "showed the unmistakable development and transversal segmentation of the embryo." § They were, however, non-productive, owing, it is supposed, to external conditions, but K. Lindeman's opinion, after experiments, is that the perfect insect is not parthenogenetic.‖

Parasites.

I have already stated that the apparent absence of the Hessian fly which immediately succeeds its superabundance is supposed to be largely due to parasites. Curtis¶ similarly accounts for the same phenomenon in the case of the wheat-midge. Meteorological conditions must, of course, exert a powerful influence on all insects, but there is little to guide us as to the way the Hessian fly may be affected, except indeed the knowledge that in America the chinch-bug, which requires dry weather, is abundant when the Hessian fly is scarce. We are thus led to think that these gnats, in some stage of development, require a certain degree of moisture, and this is confirmed by K. Lindeman's experiments.** But whether this be the fact or not, all observers are agreed as to their great destruction by parasites; and B. Wagner†† found on dissection sixty to seventy per cent. of the puparia to be thus attacked.‡‡ These friends to the agriculturist are hymenopterous insects. The female places an egg in the egg (?), larva, or pupa of the Hessian fly. The resulting larval parasite consumes the substance of its host, whose puparium furnishes it with a pupal protection. The importance to be attached to such parasites, from an economic point of view, cannot be over-rated. [Since this paper was read I have had ample opportunity of examining the puparia of this summer's brood. Only about 10 per cent. contained parasites, which were on the 20th July almost fully developed, and two emerged on the 23rd. In a few days they would have laid eggs in the larvæ of the Hessian flies, which, though in puparia, had

* 'Zeitschrift für wissenschaftliche Zoologie,' vol. xiv, p. 392.
† *Ib.* vol. xiv, p. 400.
‡ 'Archiv für Naturgeschichte,' 1865, p. 286.
§ 'North American Entomologist,' vol. i. p. 65.
‖ 'Bull. Soc. Imp. Moscou,' 1887, p. 400.
¶ 'Farm Insects,' p. 270. ** Op. cit. p. 414. †† Op. cit. p. 33.
‡‡ It must be borne in mind, however, that it by no means follows that a parasite which emerges from a pupa is parasitic on the species to which the pupa belongs. It may be a parasite of the original parasite, or, in other words, a secondary parasite.

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not yet entered the pupal stage. Unlike their hosts, they obtain freedom by gnawing a small hole in the sheath of the plant. The parasites I have reared may be classified as follows, viz. two species of the genus *Pteromalus*, two of the genus *Eutedon*, and one of each of the genera *Eupelmus* and *Dacnusa*. The Rev. T. A. Marshall has identified one of these species as *Eutedon Epigonus* Walk., which belongs to the British Fauna. The periods of its appearance were in April from the puparia of last year, and in July from the puparia of this year. The same entomologist informs me that the *Dacnusa* is closely allied to *D. senilis*, Hal., also a common species of which it may be a small variety.]

It is interesting to see that the disappearance of the Hessian fly is sudden, inasmuch as we might infer this from the following theoretical calculation as to the action of the parasites. Let us begin with four pairs of Hessian flies and one pair of parasites, and let us suppose that every female lays, say, 70 eggs, which are productive of 35 pairs. As every egg of the parasites in its development cancels what would become a fly, we may deduct from each generation of flies the whole of the eggs of the synchronic generation of parasites. We thus find that the fourth brood of flies numbers 3,001,250, all of which would be required to receive the eggs of the parasites (even if there are only two broods in a year), and would therefore be destroyed.*

A monograph by Riley† describes and figures five species of parasites of the fly in America, viz. *Merisus destructor*, Say; *Merisus* (*Homoporus*) *subapterus*, n.sp.; *Eupelmus Allynii*, French; *Platygaster Herrickii*, Packard; *Tetrastichus productus*, n.sp. By far the most abundant is *Merisus destructor*, Say (=*Semiotellus destructor*, Say), and Packard attributes to this fly alone the general immunity in some regions (U.S.) from the pest.‡ Lindeman § has recently mentioned seven, and described six species as having emerged from the puparia of the Hessian fly in Russia, viz. *Merisus intermedius*, n.sp.; *Tetrastichus Rileyi*, n.sp.; *Semiotellus nigripes*, n.sp.; *Eupelmus Karschii*, n.sp.; *Platygaster minutus*, n.sp.; *Euryscapus saltator*, n.sp.; *Platygaster* (?) sp.; and he points out the interesting fact that these are all different from those of America enumerated by Riley. Such being the case, the question arises whether, if we observe the parasites which proceed from the puparia of *C. destructor* in our own country, we may not obtain some indication as to the source from which this

* The calculation is theoretical. The figures are as follows:—

	Hessian Flies.	Parasites.
1st Generation	280—70=210	70
2nd „	7,350—2,450=4,950	2,450
3rd „	171,500—85,750=85,750	85,750
4th „	3,001,250—3,001,250=0	3,001,250

† "On the Parasites of the Hessian Fly," 'Proc. U.S. National Museum,' 1885, p. 413.

‡ 'Third Rep. U.S. Comm.,' p. 218.

§ "Die Pteromalinen der Hessenfliege," 'Bull. Soc. Imp. Naturaliste de Moscou,' 1887, p. 178.

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pest reached us. We can be confident that, from wherever we imported the puparia, some of them were tenanted by parasites. I have no doubt, however, that although there is uniformity in most parasites as to the selection of their hosts, there are indigenous species of the Chalcid genera sufficiently polyphagic to infest any foreign insect, such as the Hessian fly, which may effect a lodgment in our country. I cannot identify any of the parasites I have reared from the puparia with the Russian or American species.

Precautionary Measures.

In America considerable importance is advisedly attached to the late sowing of wheat, so that it should not be above the ground when the Hessian flies reach maturity in autumn. In our country the seed time is such as to preclude any chance of the crop being attacked before spring. There are, however, other methods recommended in America which are not always practicable in this country. If for instance the stubble were left long it could be burned, and the hybernating puparia would be destroyed—but this for obvious reasons cannot be generally practised. Or again, if the stubble were ploughed under, the result would be efficacious. But straw is valuable with us, and in very many places the soil is not deep enough for anything but surface-ploughing. Rolling has been recommended, but it is a question whether the minute larvæ and eggs would not escape pressure. One important matter appears, however, to have been overlooked by the Americans, and that is the presence of the puparia in the siftings from the threshing-machine. This was first observed by Mr. Palmer, and at once made public by Miss Ormerod. We cannot doubt that the debris contains other enemies to crops besides the Hessian fly. All such refuse should be burnt, and straw in manure should be well heated. The parasites are deemed so useful by the American entomologists that where the Hessian fly and parasites appear co-existent, they would risk retaining the fly rather than destroy the two together. I do not in the least sympathize with this precaution. If a thing must be done, and we can easily do it ourselves, why leave the performance to others, even to parasites? Moreover, the burning of the puparia in our siftings does not disturb the balance which exists in neighbouring fields between the flies and the parasites.

The fields which I have found to be the worst attacked were those adjoining clover, which, having been sown with barley or wheat, must have contained in autumn many self-sown plants, thus providing a suitable nidus for the brood of that season. It would be advisable not to sow clover with these cereals.

It seems that the most important precautions to be taken are the most elementary, viz. that the seed sown should be of a kind giving good strong straw, and that all means should be taken to secure vigorous growth. This leads me to refer to the old Hebrew dictum of the indispensable necessity that land should sometimes lie fallow. The barley which suffered the most on the Revell's Hall Farm was grown on spots of poor soil, while barley

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with stronger straw, on a field of good soil, was not supposed to be attacked, so well it looked, and yet was found on threshing to contain more puparia than any other. Of course, bad seasons like 1886 reduce the vitality of every plant, but so far the limited English experience has been the same as the wider one of America, viz. that a healthy plant, grown on good soil, may be sufficiently strong not to suffer from the withdrawal, by one or two larvæ, of a portion of its sap. Further, the stronger stem may, in addition, offer a resistance to their rudimentary mouths and anchor, in the same manner that the thicker-cuticled American vines appear to partly withstand the attacks of the *Phylloxera vastatrix*. But whatever consolation such considerations may encourage, we must not forget that, notwithstanding all the knowledge of the Americans, the loss occasioned in 1885 * by the Hessian fly in the State of New York was £26,000, and was much more severe in some other States. Every practicable precaution will of course always have to be taken against every pest, but it appears that the vigour and intrinsic health of the particular plant attacked are its best safeguards. There always will be pests, and that plant will come out best in the end which can best endure the bleeding of its natural sap. A strong plant may produce well, after having suffered depletion that would have destroyed a weaker plant.

General Observations.

It is a strange coincidence that the wheat-midge (*Cecidomyia tritici*, Kirby), like the Hessian fly, was first observed in Hertfordshire (1795),† and it was only two years later that Kirby wrote that he had not examined in his walks any ear of wheat which was "not inhabited by these larvæ."‡ It is unnecessary to detail the constant injury done to the crops by that insect. It is to be hoped that the same will not be said of the Hessian fly. I am no alarmist, but must hold that a serious danger threatens us. It would be well if the members of our Society were not only to ascertain if the new pest had visited their neighbourhood, but also to make known the precautionary measures which should be adopted.

I am inclined to think that the Hessian fly has been comparatively recently introduced into the United Kingdom, for it could scarcely have escaped the enquiries of Sir Joseph Banks, Kirby, Curtis, and other entomologists. The only evidence I have which bears upon the length of its settlement with us is that of a farmer at St. Margarets, who told me that, just before harvest, twenty-five years since, at Mary Hill, Glasgow, having accidentally observed a puparium in wheat, he was led to examine the stalks of sickly ears, in which he found others. He correctly described to me the puparium and its position, and on my showing him one *in situ*, stated that those he had seen were the same, but of a

* 'Report of President of Entomological Soc. of Ontario,' 1886.
† 'Trans. Linn. Soc.' vol. iii, p. 242.
‡ Op. cit. vol. iv, p. 231.

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brighter red colour. This could be explained if they had been recently formed. But he added that he had found them also on oats during the same year. Now, as already mentioned, all observers agree that the Hessian fly does not attack oats, and this leads me to think he must have been mistaken. The question arises,—Whence has it come? The answer can only be speculative. It is more easy to form an opinion as to the means of its introduction. There is a great quantity of straw imported as straw, and also in manure;* and it is used also generally for packing. It is impossible not to admit how easily the puparia or flax-seeds could, in such manner, be conveyed—first to our ports, and then all over the country. Miss Ormerod, to whom agriculturists are already much indebted for the publicity given to the remedies against injurious insects, informs me that, having organized a search amongst imported straw at our ports, she has received and identified one puparium of the Hessian fly which came from Belgium. At the same time her correspondents in that country, and in the Netherlands, inform her that the Hessian fly has not yet been discovered there.

The new indenization of any animal is of the greatest interest to a naturalist; but, independently of this general view, there are points connected with *Cecidomyia destructor*, Say, on which further information is required. I refer more particularly to—(*a*) Whether wheat, barley, and rye are the only food-plants of its larvæ? In other words, are these cereals the essential, or only the preferred nidi? (*b*) The identification of its parasites; and (*c*) Whether the larvæ, like others of the same genus, are capable of agamogenetic reproduction?

The injury inflicted on our crops by this insect pest may as yet be comparatively slight, but with the knowledge of its devastations in America, we should be more than careless if we neglected precautionary measures.

[I regret to add that the *C. destructor* now (July) infests every barley and wheat field in this parish (Hoddesdon), and I have found it on farms in Hertford, Ware, Stanstead, Amwell, St. Margaret's, Broxbourne, Wormley, Cheshunt, and Stanstead Mountfitchet, near Bishop's Stortford. The puparia in the wheat are situated just above the first joint, and sometimes at the crown of the root,—and these will therefore remain with the stubble. Early ploughing would be of considerable service. Some Americans recommend feeding off with sheep, under the impression that the puparia would be trampled on. Barley is attacked more than wheat, and I have found as many as seven puparia on one stem.] †

* Mr. G. E. Palmer informs me that large quantities of manure from London have been used on Revell's Hall Farm for the last five or six years: some of the straw may have been imported.

† The figures illustrating this paper are kindly lent by Miss E. A. Ormerod, from her pamphlet on 'The Hessian Fly.'—Ed.

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XXI.

A NATURALIST'S CALENDAR FOR THE NORTHERN BORDER OF HERTFORDSHIRE.

By H. George Fordham, F.G.S.

Read at Watford, 19th April, 1887.

From observation of the phenomena given below during the ten years period 1877–86, I have been able to construct a Naturalist's Calendar for a district lying on the extreme northern border of Hertfordshire, and embracing the most southerly part of Cambridgeshire. Some of the phenomena have, unfortunately, not been observed in every year throughout the whole period, but on the whole the mean dates given in the Calendar may be taken to be fairly trustworthy.

In three columns are given the earliest, latest, and mean dates of occurrence of the various phenomena, and, in a fourth, for the purpose of comparison, the mean of the earliest recorded dates for Hertfordshire for the ten years 1876–85, as published in the Transactions of this Society, Vol. IV, p. 93.

It will be seen that there is, as would be expected, a well-marked difference, varying from 1 to 28 days (the mean date being the same, however, in one instance), between the mean dates up to the end of July; Odsey being later than the mean of the earliest dates recorded anywhere in the county by an average (in the months of January to July) of 7·9 days. The autumn observations are too few to rely upon, but they appear to indicate the earlier southern movement of the summer migrants from the north of Herts than from the county generally.

As phenological observations are now generally recorded by reference to the day of the year, and not of the month, I have inserted in all cases the day of the year, in order to facilitate comparison with other records, retaining at the same time the day of the month, as more readily understood by those who are not in the habit of referring to the former method of computing.

The numbers in parenthesis in the first column are those used in the Royal Meteorological Society's list of species recommended for observation.

Particulars of Locality.

Place: *Odsey.* Counties: *Hertfordshire and Cambridgeshire* (borders of). Longitude: 0° 6′ 41″ W. Latitude: 52° 1′ 28″ N.

Area of observation: *a radius of 2 miles.*

Elevation above sea: 150–500 *feet* (*Odsey* 263 *feet*).

Geology: *Chalk, with patches of boulder-clay and gravel.*

Natural features: *open arable fields and small plantations* (*very little pasture; no mountain, swamp, or moor*).

Rainfall: *mean of* 10 *years*, 1877–86, 23·53 *inches; highest in these ten years*, 28·24 *ins.* (1879); *lowest*, 16·15 *ins.* (1884); *mean number of wet days*, 174; *highest*, 193 (1877); *lowest*, 142 (1884).

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NATURALIST'S CALENDAR FOR NORTH HERTS.

Phenomena.	Odsey, 1877–86. Earliest.		Odsey, 1877–86. Latest.		Odsey, 1877–86. Mean.		Herts, 1876–85. Mean.	
January.								
Song-thrush—*Turdus musicus* (93)—sings	Jan. 2	2	Feb. 12	43	Jan. 20	20	Jan. 12	12
Skylark—*Alauda arvensis* (99)—sings	Jan. 2	2	Feb. 7	38	Jan. 22	22	Jan. 16	16
Partridge—*Perdix cinerea* (109)—pairs	Jan. 19	19	Feb. 7	38	Jan. 27	27	Jan. 24	24
Snowdrop—*Galanthus nivalis* (78)—fl.	Jan. 13	13	Feb. 17	48	Jan. 28	28	Jan. 22	22
February.								
Hazel—*Corylus Avellana* (74)—fl.	Jan. 15	15	Mar. 6	65	Feb. 7	38	Jan. 25	25
Honey-bee—*Apis mellifica* (84)—appears	Jan. 20	20	Mar. 7	67	Feb. 11	42	Jan. 25	25
Yew—*Taxus baccata*—fl.	Jan. 21	21	Mar. 9	68	Feb. 17	48	.....	.....
Rook—*Corvus frugilegus* (101)—roosts on nest-trees	Feb. 22	53	Mar. 4	64	Feb. 26	57	.....	.....
Rook—*Corvus frugilegus* (101)—builds	Feb. 23	54	Mar. 5	64	Feb. 28	59	Feb. 20	51
March.								
Coltsfoot—*Tussilago Farfara* (45)—fl.	Feb. 10	41	Mar. 21	80	Mar. 1	60	Feb. 23	54
Wych Elm—*Ulmus montana* (71)—fl.	Feb. 10	41	Apl. 2	92	Mar. 6	65	Feb. 27	58
Pyrus Japonica fl.	Jan. 13	13	Apl. 17	107	Mar. 9	68	.....	.....
Daffodil—*Narcissus Pseudo-narcissus* (77)—fl.	Feb. 24	55	Mar. 31	90	Mar. 10	69	Mar. 4	63
Sweet violet—*Viola odorata* (10)—fl.	Feb. 6	37	Apl. 8	99	Mar. 10	69	Feb. 10	41
Great sallow—*Salix Caprea* (72)—fl.	Mar. 2	62	Apl. 3	93	Mar. 14	73	Mar. 6	65
Royston Crow—*Corvus Cornix*—departs (last seen)	Feb. 28	59	Apl. 6	96	Mar. 19	78	.....	.....
Box—*Buxus sempervirens*—fl.	Feb. 25	56	Apl. 15	105	Mar. 21	80	.....	.....
Song-thrush—*Turdus musicus* (93)—lays	Mar. 5	64	Apl. 13	103	Mar. 21	80	.....	.....
Blackthorn—*Prunus spinosa* (27)—fl.	Feb. 18	49	Apl. 27	117	Mar. 29	88	Mar. 23	82
April.								
Cowslip—*Primula veris* (68)—fl.	Mar. 10	69	Apl. 13	103	Apl. 1	91	Mar. 18	77
Ground ivy—*Glechoma hederacea* (64)—fl.	Mar. 19	78	Apl. 18	108	Apl. 4	94	Mar. 24	83

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Song-thrush—*Turdus musicus* (93)—hatches	Mar. 20	79	Apl. 25	115	Apl. 10	100	Apl. 7	97
Rook—*Corvus frugilegus* (101)—hatches	Apl. 8	99	Apl. 19	109	Apl. 12	102	Apl. 10	100
Ash—*Fraxinus excelsior*—fl.	Mar. 26	85	May 3	124	Apl. 17	107	.....	.....
Wild chervil—*Anthriscus sylvestris*—fl.	Mar. 19	78	May 11	131	Apl. 20	110	Apl. 5*	95
Nightingale—*Daulias Luscinia* (95)—arrives (first heard)	Apl. 12	102	Apl. 26	117	Apl. 20	110	Apl. 13	103
Swallow—*Hirundo rustica* (103)—arrives	Apl. 14	104	Apl. 29	119	Apl. 21	111	Apl. 11	101
Cuckoo—*Cuculus canorus* (102)—arrives (first heard)	Apl. 18	108	Apl. 30	121	Apl. 23	113	Apl. 10	100
MAY.								
Turtle dove—*Turtur communis* (108)—arrives	May 1	121	May 12	133	May 7	127	May 4*	124
Hawthorn—*Cratægus oxyacantha* (32)—fl.	Apl. 22	112	June 1	152	May 10	130	May 10	130
Swift—*Cypselus apus* (106)—arrives.....	May 9	129	May 17	137	May 13	133	May 5	125
Milkwort—*Polygala vulgaris* (11)—fl.	Apl. 24	114	June 7	158	May 16	136	May 7	127
Silverweed—*Potentilla anserina* (29)—fl.	Apl. 30	121	June 4	155	May 17	137	May 15	135
Flycatcher—*Muscicapa grisola* (92)—arrives	May 8	128	May 30	151	May 17	137	May 12	132
Cleavers—*Galium aparine* (40)—fl.	May 8	128	June 6	158	May 19	139	May 15	135
Laburnum—*Cytisus Laburnum* (21)—fl.	Apl. 30	120	June 5	156	May 19	139	May 12	132
Red poppy—*Papaver Rhœas* (5)—fl.....	May 19	139	June 16	167	May 31	151	May 28	148
JUNE.								
Dog-rose—*Rosa canina* (30)—fl.	May 23	143	June 24	175	June 6	157	June 3	153
Common mallow—*Malva silvestris* (14)—fl.	May 30	150	July 3	184	June 15	166	June 6	157
JULY.								
Ragwort—*Senecio Jacobæa* (49)—fl.	June 23	174	July 15	196	July 6	187	June 29	180
Yellow bedstraw—*Galium verum* (41)—fl.	June 27	178	July 26	207	July 8	189	June 29	180
AUGUST.								
Flycatcher—*Muscicapa grisola* (92)—departs (last seen)	Aug. 18	230	Sept. 11	255	Aug. 31	243	Aug. 30	242
Swift—*Cypselus apus* (106)—departs (last seen)	Aug. 20	232	Sept. 6	250	Aug. 31	243	Sept. 7	250
OCTOBER.								
Swallow—*Hirundo rustica* (103)—departs (last seen)	Oct. 10	283	Nov. 1	306	Oct. 18	291	Oct. 26	299
Royston crow—*Corvus Cornix*—arrives	Oct. 6	280	Nov. 2	306	Oct. 19	292	.....	.....
NOVEMBER.								
Fieldfare—*Turdus pilaris* (94)—arrives	Oct 29	302	Nov. 25	329	Nov. 8	312	Oct. 20	293

* Mean, 1876–82, 'Trans. Herts N.H.Soc.,' Vol. II, pp. 182, 184.

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XXII.

OBSERVATIONS ON DIATOMACEÆ FROM THE NEIGHBOURHOOD OF HERTFORD.

By Isaac Robinson.

Read at Hertford, 24th February, 1887.

About three years ago I read a short paper on the Diatomaceæ * with particular reference to the species found in our own county. Since that time Mr. Francis Ransom has contributed a paper on the same subject,† which, however, dealt principally with the nature and habits of these organisms. It might therefore be considered that a third paper was superfluous at the present time. My apology, however, must be that I have been enabled to make considerable additions to the list of local species, and that some facts of an interesting character, in reference to the distribution and reproduction of the Diatomaceæ, have come under my notice.

Diatoms are characterised by the possession of silicious epiderms which usually consist of two symmetrical valves and a connecting hoop, the three parts together enclosing the living substance of the organism. This living substance consists of a mucilaginous fluid, invested in a membranous sac or covering, in which float the granules of endochrome, giving to the living frustule a golden-brown colour. This unicellular constitution of the organism appears to be one of great simplicity, and it never ceases to my own mind to be a subject of wonder how it is enabled to produce those beautiful frustules which are the delight of the microscopist; which, whether circular, oval, hexagonal, oblong, or otherwise, are so marvellously perfect; and which, with all their delicate design and tracery, are formed of a material of so indestructible a character as well-nigh pure silica.

The Diatomaceæ are found in fresh water, in brackish water, and in the sea, much the larger number being fresh-water and marine forms. Our own county, as a matter of course, only affords examples of the fresh-water species. The number of these found in Great Britain, as recorded by Professor Smith,‡ was 238, and some others have, since the publication of his work, been added by other observers. The number of species recorded as found in our own county up to the present time is about 150, nearly the whole of which have been found near Hertford, although many of them have been also recorded from elsewhere. A list of the species is appended. Two species, which are not included in the list, may be mentioned here, for, though they must be regarded as absentees from our own county so far as present observation has gone, they have been found not far distant from its boundaries. One is *Asterionella formosa*, found in the canal of the East London Water Works near Lea Bridge, and the other is *Gomphonema geminatum*, found in Epping Forest.

* 'Trans. Herts Nat. Hist. Soc.,' Vol. III, p. 1. † *Ib.* p. 197.

‡ 'Synopsis of the British Diatomaceæ,' 1853-56.

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One species included in the local list—*Achnanthes inflata* (Grunow) =*Monogramma ventricosa* (Ehr.)=*Stauroneis inflata* (Kutz.)—is a very rare form, and appears to have been found only once previously in Great Britain. I first discovered it in September, 1882, on moss (*Hypnum riparium*) growing in the River Lea, on a stone step by my own garden at Hertford. I found it again in July, 1885, under exactly the same conditions, but recent searches for it have proved fruitless. Some of the specimens were identified by Mr. Kitton of Norwich, who mentions it in his list of the Diatomaceæ of Norfolk as *Achnanthes ventricosa* (Ehr.), and who informs me that he once found it in some moss-washings in that county, and that he was not aware of any other British habitat. It has been found plentifully in New Zealand.

I met with another species of *Achnanthes* in October, 1883, which I then considered to be *Achnanthes subsessilis*. On a more careful examination, however, it did not appear to coincide clearly with any described species, and it was afterwards thought by Mr. Kitton to be what he termed a "starved condition" of *Achnanthes coarctata*. It was growing, at the time I found it, on a large flower-pot containing a plant of *Agapanthus umbellatus*, in my garden at Hertford. I found it subsequently, in September, 1885, growing on the same flower-pot, where I believe it still continues to flourish.

Another instance of the localisation of a particular form is afforded in the case of *Denticula sinuata*, a species mostly found in mountainous districts. I have repeatedly found it growing in a small pond near Pembridge Lane, but never elsewhere in the county.

The distribution of the Diatomaceæ is much assisted by the swollen condition of our streams and rivers after heavy rain, and in many cases they contribute an appreciable proportion of the muddy colouring matter which the rivers contain. On the 8th of April, 1886, I took from the River Lea at Hertford, for the purpose of microscopical examination, one pint of water. The water was at the time much discoloured in consequence of there having been a considerable rainfall on the previous day, amounting to nearly half an inch. On carefully examining the solid matter contained in this small quantity of water, I was surprised to find upwards of fifty species of Diatomaceæ, some of which were very numerously represented. I should state that these were not such as were simply floating on the river, but that, after agitating the surface of the water, the bottle was filled by placing its neck several inches below the surface. This distribution is further facilitated by dry dust in summer, and by what are known as dust storms, in the solid matter of which Ehrenberg detected upwards of a hundred species.

The usual mode of increase of the Diatomaceæ is by the process of self-division, by which one frustule becomes two frustules. This is accomplished by the division of the cell-contents into two portions, each one of which commences forthwith the formation of a new

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valve internally. When this is completed the two portions separate, each possessing one old and one new valve, and thus two perfect plants take the place of the original one. By each of these the process is continued, and therefore the increase of numbers proceeds in a constantly augmenting proportion. The exact time occupied in this process of self-division is not known, but probably under favourable circumstances it proceeds very rapidly. It is not, however, regarded as one of true reproduction, but is considered to be more analogous to that of gemmation. It would appear also that it cannot be continued indefinitely, but that, after a time, probably from the exhaustion of the vital energy of the plant, a process of sporangial reproduction intervenes. The instances in which this latter stage has been observed are, however, comparatively rare, and very little is known definitely with regard to it. Professor Smith, in 1856, enumerated thirty-two species in which it had been observed, and O'Meara stated, in 1875, that twenty-eight others had in the interval been added to the list. The precise method adopted in the formation of the sporangia appears to vary in different species, but the general characteristic of the process is the production of greatly enlarged frustules, resulting from the union of the cell-contents of the parent frustules. These enlarged frustules are doubtless the parents of a new generation, but much careful observation and study are still required to trace the process satisfactorily throughout. One of the subsequent stages appears to be the production of cysts, containing many young specimens closely packed together, which on arriving at maturity doubtless separate and start in life on their own account. Although such examples are rare, I have been so fortunate as to meet with a few instances in our own locality, which illustrate different stages of this sporangial development. Perhaps the most interesting of these occurred in October last, when I found in a broad ditch in the King's Meads, about midway between Hertford and Ware, a large number of very perfect specimens of the sporangia of *Cymbella Ehrenbergii*. This species is not included in Smith's list of observed species, and I am not aware that it has previously been met with. The sporangial frustules were much larger than their usual size, and much more nearly approached a symmetrical form.

In April, 1886, I found in some material taken from the River Beane, on Waterford Marsh, a large number of cysts of *Cymatopleura apiculata*. Some of these contained a considerable number of young specimens, in various stages of development, and of various sizes. In the smaller specimens the wavy outline peculiar to this species was not apparent, although it was clearly shown in the larger ones. One characteristic of these cysts, which struck me as very peculiar, was the association of frustules of different genera in the same cyst. Thus I found that *Cymatopleura apiculata* was in very many instances associated with a small *Surirella*—probably *S. crumena*—and, from the number of examples which I observed, I think the association could not have been purely accidental. I also found a number of similar specimens amongst some

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material subsequently collected, in the following June, in the same locality, which, in addition thereto, contained a number of large cysts of *Synedra Ulna*. In the same collection I also found examples of the sporangial development of several other species, amongst which were *Gomphonema constrictum* and *Pinnularia viridula*, and also some singular specimens of *Odontidium mutabile*, the constituent frustules of the filaments of which were of very unequal size. This condition is a most unusual one, as the filaments are generally of uniform width throughout, even if of considerable length. I can only account for it on the supposition that they were the result of sporangial development.

With reference to the uses of the Diatomaceæ, and the place which they occupy in the economy of Nature, we appear to have but little knowledge. We cannot doubt but that they accomplish some useful purpose. Aggregated in numbers that defy all efforts of numerical computation, it is possible that by the absorption of carbonic acid and the production of oxygen, they may do much to maintain the purity of the waters in which they are found.

LIST OF HERTFORDSHIRE DIATOMACEÆ.

Epithemia turgida, *W. Sm.*
,, granulata, *Kutz.*
,, alpestris, *W. Sm.*
,, Sorex, *Kutz.*
,, Westermanii, *Kutz.*
,, gibba, *Kutz.*
,, ventricosa, *Kutz.*
,, Zebra, *Kutz.*
Eunotia Arcus, *W. Sm.*
Cymbella Ehrenbergii, *Kutz.*
,, cuspidata, *Kutz.*
,, ventricosa, *Kutz.*
Amphora ovalis, *Kutz.*
,, minutissima, *W. Sm.*
Cocconeis Pediculus, *Ehr.*
,, placentula, *Ehr.*
Cyclotella Kutzingiana, *Thw.*
,, operculata, *Kutz.*
,, Rotula, *Kutz.*
Campylodiscus costatus, *W. Sm.*
,, spiralis, *W. Sm.*
Surirella biseriata, *De Bréb.*
,, linearis, *W. Sm.*
,, splendida, *Kutz.*
,, nobilis, *W. Sm.*
,, craticula, *Ehr.*
,, ovalis, *De Bréb.*
,, angusta, *Kutz.*
,, minuta, *De Bréb.*
,, Amphioxys, *W. Sm.*
,, crumena, *De Bréb.*
Tryblionella gracilis, *W. Sm.*
,, angustata, *W. Sm.*
Cymatopleura Solea, *W. Sm.*
,, apiculata, *W. Sm.*
,, parallela, *W. Sm.*
,, elliptica, *W. Sm.*
Nitzschia sigmoidea, *W. Sm.*
,, linearis, *W. Sm.*
,, tenuis, *W. Sm.*
,, Amphioxys, *W. Sm.*
,, vivax, *W. Sm.*
,, dubia, *W. Sm.*
,, acicularis, *W. Sm.*
,, plana, *W. Sm.*
,, palea, *W. Sm.*
Amphipleura pellucida, *Kutz.*
Navicula crassinervia, *De Bréb.*
,, serians, *Kutz.*
,, cuspidata, *Kutz.*
,, rhynchocephala, *Kutz.*
,, firma, *Kutz.*
,, ovalis, *W. Sm.*
,, minutula, *W. Sm.*
,, affinis, *Ehr.*
,, inflata, *Kutz.*
,, gibberula, *Kutz.*
,, amphirhynchus, *Ehr.*
,, producta, *W. Sm.*
,, ambigua, *Ehr.*
,, amphisbæna, *Bory.*
,, sphærophora, *Kutz.*
,, pusilla, *W. Sm.*
,, tumida, *W. Sm.*
,, dicephala, *Kutz.*
,, cryptocephala, *Kutz.*

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Navicula binordis, *Ehr.*
,, Bacillum, *Ehr.*
,, Rostellum, *W. Sm.*
,, Gastrum, *Ehr.*
,, limosa, *Kutz.*
,, Tabellaria, *Ehr.*
,, gentilis, *Donk.*
Pinnularia major, *W. Sm.*
,, viridis, *W. Sm.*
,, oblonga, *W. Sm.*
,, lata, *W. Sm.*
,, acuta, *W. Sm.*
,, radiosa, *W. Sm.*
,, gracilis, *Ehr.*
,, viridula, *W. Sm.*
,, divergens, *W. Sm.*
,, stauroneiformis, *W. Sm.*
,, gibba, *Ehr.*
,, mesolepta, *Ehr.*
,, interrupta, *W. Sm.*
,, borealis, *Ehr.*
Stauroneis Phœnicenteron, *Ehr.*
,, gracilis, *Ehr.*
,, acuta, *W. Sm.*
,, anceps, *Ehr.*
,, —— *var.* gracilis, *Rab.*
,, linearis, *Ehr.*
Pleurosigma attenuatum, *W. Sm.*
,, lacustre, *W. Sm.*
,, Spencerii, *W. Sm.*
Synedra lunaris, *Ehr.*
,, bi-lunaris, *Ehr.*
,, pulchella, *Kutz.*
,, minutissima, *Kutz.*
,, radians, *W. Sm.*
,, Ulna, *Ehr.*
,, oxyrhynchus, *Kutz.*
,, obtusa, *W. Sm.*
,, capitata, *Ehr.*
,, delicatissima, *W. Sm.*
,, hamata, *W. Sm.*
,, Vaucheriæ, *Kutz.*
,, tenera, *W. Sm.*
Cocconema lanceolatum, *Ehr.*
Cocconema cymbiforme, *Ehr.*
,, Cistula, *Ehr.*
,, parvum, *W. Sm.*
Gomphonema constrictum, *Ehr.*
,, acuminatum, *Ehr.*
,, cristatum, *Ralfs.*
,, dichotomum, *Kutz.*
,, tenellum, *W. Sm.*
,, capitatum, *Ehr.*
,, olivaceum, *Ehr.*
,, intricatum, *Kutz.*
,, Vibrio, *Ehr.*
,, curvatum, *Kutz.*
,, Cygnus, *Ehr.*
Meridion circulare, *Ag.*
Himantidium pectinale, *Kutz.*
,, Arcus, *W. Sm.*
,, gracile, *Ehr.*
Odontidium mutabile, *W. Sm.*
,, Tabellaria, *W. Sm.*
,, Harrisonii, *W. Sm.*
,, parasiticum, *W. Sm.*
Denticula tenuis, *Kutz.*
,, sinuata, *W. Sm.*
Fragillaria capucina, *Desm.*
,, virescens, *Ralfs.*
Achnanthes subsessilis, *Kutz.*
,, exilis, *Kutz.*
,, inflata, *Grunow.*
Achnanthidium lanceolatum, *De Bréb.*
,, lineare, *W. Sm.*
Diatoma vulgare, *Bory.*
,, elongatum, *Ag.*
Tabellaria flocculosa, *Kutz.*
,, fenestrata, *Kutz.*
Melosira varians, *Ag.*
Orthosira arenaria, *W. Sm.*
,, orichalcea, *W. Sm.*
,, spinosa, *W. Sm.*
Encyonema prostratum, *Ralfs.*
,, cæspitosum, *Kutz.*
Colletonema vulgare, *Thw.*
,, neglectum, *Thw.*
,, subcohærens, *Thw.*

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XXIII.

REPORT ON INSECTS OBSERVED IN HERTFORDSHIRE DURING THE YEAR 1886.

By F. W. Silvester, F.R.Met.Soc.

Read at Watford, 19th April, 1887.

The following observations of the first appearance of the insects in the Royal Meteorological Society's list have been made by Mr. Hopkinson of Watford (now St. Albans); Mr. Willis of Harpenden; Mr. R. T. Andrews of Hertford; and Miss Simpson of High Wych near Sawbridgeworth.

Melolontha vulgaris (cock-chafer), seen at Harpenden, May 28th; at Hertford, April 19th.

Timarcha lævigata (bloody-nosed beetle), seen at Harpenden, March 23rd.

Apis mellifica (honey-bee), seen at Harpenden, March 17th; at Watford, March 19th; at High Wych, March 24th.

Vespa vulgaris (common wasp), seen at Harpenden, January 28th.

Pieris brassicæ (large white cabbage-butterfly), seen at Hertford, April 19th; at Watford, April 23rd.

P. rapæ (small white cabbage-butterfly), seen at Watford, April 5th; at Harpenden, April 24th.

Anthocharis Cardamines (orange-tip butterfly), seen at Harpenden, May 2nd.

Epinephele Janira (meadow-brown butterfly), seen at Watford, June 2nd.

Bibio Marci (St. Mark's fly), seen at Watford, April 25th.

The most important insect attack of the year 1886 has been that of the Hessian fly, which was first seen in this country on the 27th of July, when specimens of the flax-seed-like puparia were forwarded to Miss E. A. Ormerod by Mr. G. E. Palmer, from his barley-fields near Hertford. Not only our own county, but the whole of England, is indebted to the Consulting Entomologist of the Royal Agricultural Society for having lost no time in verifying the attack by a personal visit to the place where Mr. Palmer first discovered the dreaded "flax-seeds," and for her subsequent observations, as set forth in her pamphlet on 'The Hessian Fly.'

On the 30th of July Miss Ormerod examined the fields near Hertford, and found the barley-stems doubled sharply down, usually a little above the second joint, and between this elbow and the joint below there lay, closely pressed to the stem, and covered by the sheathing leaf, the flax-seed-like chrysalis cases. Sometimes a gall or some amount of swelling of the stem occurs just above where the maggot feeds, but in the specimens which Miss Ormerod examined this was rarely noticeable.

"On the 8th of September the first fly developed from the puparia. This, to the naked eye, was a stout-made little brown gnat with a darker head and body, legs of a rather light brown,

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brown horns, and a pair of smoky-grey wings with longitudinal veins. It was exactly ¼ of an inch in length."

As our President, Mr. Campbell, is to read a paper on the Hessian fly,* and entomological detail will receive fuller justice at his hands, I will pass on to the other notes with which I have been favoured, expressing a hope that if any appearance of the Hessian fly comes within the notice of any members of this Society, they will kindly undertake to see that all the facts are at once forwarded to me as the County Recorder, or direct to Miss Ormerod at Torrington House, St. Albans.

On my own farm some rape sown in the middle of April was all eaten by the turnip-fly before the 4th of May. It was sown again, and a genial rain got it out of the power of insect-attack.

The wire-worm attacked the barley early in May, but a dressing of nitrate of soda and a heavy rolling were efficacious in preventing any serious harm from being done.

In the month of September caterpillars were very troublesome on the greens in my garden. I had them hand-picked and destroyed.

The closing remarks of my last year's report with regard to the large swarm of aphides seen at St. Albans and Wheathampstead appear to have awakened much interest, for a letter appeared in the 'Hertfordshire Standard' reiterating the statement, and mentioning that the writer of the paragraph knew the names of the people who saw the swarm. I have not yet been favoured with them. It also called forth the following interesting notes from Mr. Willis of Harpenden :—

"There is certainly no tribe of insects so universally distributed, or that multiplies to such an enormous extent, as the aphides or plant-lice.

> "Feeble race! yet oft
> The sacred sons of vengeance, on whose course
> Corrosive famine waits, and kills the year!

"The year 1885 was certainly most prolific in the distribution of the great Aphis family in this neighbourhood, almost every variety of plant appearing to support its own distinct species of aphis, and the ravages committed by this pest were very extensive.

"On the first day of August, I myself observed a vast host of green and black flies, not 'several hundreds of yards in extent,' or forming 'a dense black cloud,' but that filled the atmosphere, especially in the vicinity of some chestnut trees in the village of Harpenden, with myriads of slender and delicately-winged insects; and some newly painted wood-work in the village became literally coated with the creatures. From their appearance they seemed to be *Aphidius Rapæ*, a parasitic fly which is said by Curtis to be one of the most formidable enemies of the plant-lice, thus pointing to the fact that Providence is ever watchful of all his works, and, regarding in the smallest as well as the greatest, that balance which preserves the order of the universe, provides in years of greater

* See *ante*, p. 180.

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prominence of any particular pest, suitable enemies to keep in check the destroyers of the flowers in our gardens, and the crops in our fields.

"Amongst the most conspicuous and efficient enemies of the great Aphis family are the Coccinellæ, of which about thirty different species are said to have been noticed in England, varying among themselves in colour and markings to as great an extent as any of our domestic animals.

"These pretty beetles, well known by the familiar name of '*Lady Birds*' or '*Virgin's Insects*,' were observed by me during the winter of 1884-5, hybernating in the crevices of palings and old wood-work, and in dry leaves and grass-tufts upon the ground, in companies of thousands; bunches which would have filled a half-pint measure congregating together like newly-swarmed bees. These little creatures withstood the severity of the winter season in a most remarkable manner, no amount of frost or cold seeming to injure them. They were observed to remain in their apparently dormant condition until the end of April, when they all took their departure, whether by flight of wing or otherwise could not be ascertained. They had eight black spots on each of their amber-coloured wings, arranged in two rows, the four lower spots being more or less blended into one continuous blotch. Would the species be *C. octavumpunctata*?

"During the present winter of 1885-6 a few solitary lady-birds only were noticed, so, if the number of aphis destroyers can be relied upon as any indication of what the coming season is likely to be, we shall be troubled with fewer aphides than last year.

"Aphides are said to be able to propagate their kind in mild winters, but very severe frost kills them. The severity of the winter season just past will, therefore, surely have accomplished its work of destruction."

Mr. Willis appends the following notes on the past season:—

"The year 1886, taken as a whole, has not been so prolific in injurious insects as some of the more recent of the preceding years.

"During the month of May, although the cereal crops were generally looking well, we noticed large patches much injured by the wire-worm, more particularly on the lighter descriptions of soil. There was no difficulty in picking out the spots, from the yellowness of the corn-blades, and when the plant was removed a wire-worm was invariably found underneath. This destructive grub also played sad havoc among the young mangel-wurzel plants on some lands during June. A portion of one field was particularly noticeable where a heavy dressing of night-soil manure had been applied just previous to the sowing of the seed. My own opinion is that it was the *too strong manure* that destroyed the young plants, and that the wire-worm luxuriated there to feed upon the decaying roots, not that the wire-worm was the primary cause. I advocate that such very strong manures should be applied and ploughed in some time before the seed is sown (say the previous autumn).

"In many places the onion-crop was a partial failure owing to

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the ravages of *Anthomyia ceparum* (onion-fly), and in gardens of very light soil the grub of *Tipula oleracea* (crane-fly) was very troublesome. Aphides were not prevalent this season, a few only of *Aphis rumicis* and *Aphis Rotæ* being noticed. Earwigs were a great pest, several houses and gardens in this locality swarming with them. I have found comparatively few lady-birds as yet; small tufts of them have existed through the recent severe winter."

Dr. Brett has forwarded to me the following communication with regard to a plague of earwigs:—

"Mr. James, of Leavesden, informs me that he has never seen so many earwigs as in 1886. He first noticed them after the hay harvest; and in harvest when unloading a load of oats, often a pint of earwigs might be noticed. They greatly injured the turnips and swedes, eating out all the soft part of the leaves and leaving the ribs. They were also, he was told, very destructive all over the Chalk Downs at Dunstable and Dagnal, and also at Chenies."

Dr. Brett adds:—"I am told that earwigs are nocturnal in their habits, and that they sometimes pass over the road in such numbers as to make it quite dark, and in the day-time burrow underground. I am also told that earwigs do good by eating the green fly on the rose trees."

Mr. Littleboy, of Hunton Bridge, has also noticed the plague of earwigs, and many queer stories about their erratic doings have been sent to me.

In conclusion I beg to thank all who have kindly contributed to this report, and to express the hope that next year more observers will favour me with their notices.

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XXIV.

METEOROLOGICAL OBSERVATIONS TAKEN AT WATFORD DURING THE YEAR 1877.

By John Hopkinson, F.L.S., F.G.S., F.R.Met.Soc.

Read at Hoddesdon, 3rd November, 1887.

Results of meteorological observations which I have taken at Watford from the 1st of March, 1876, to the end of the year 1886, have been given in the Transactions of the Society, with the exception of the record for the last four months of 1877. During that period I removed, discontinuing observations at Holly Bank in September and commencing them at Wansford House in October. At the former place observations had been taken at both 9 a.m. and 9 p.m., at the latter they have been taken only at 9 a.m.

In order to complete the publication of the principal results of the ten years' series of observations, so that those for the first year of the series may be strictly comparable with the rest, except for the slight difference in the localities, which are only half a mile apart, I now give tables for 1877, for the first nine months for Holly Bank, and for the last three months for Wansford House, all the values being deduced from the 9 a.m. observations only.

From these tables (pp. 206, 207) the following summary for the different seasons is deduced, December, 1876 (from the report for that year), being included in the winter season, and results for Greenwich Observatory being added for comparison as usual.

Watford.

Seasons, 1876–77.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	29·766	42·5	8·1	·242	91	12·52	66	7·4
Spring	29·813	44·2	14·2	·234	78	7·88	55	7·0
Summer.....	29·950	59·6	18·2	·392	74	7·91	42	5·7
Autumn.....	29·913	48·1	16·0	·286	81	6·98	43	5·8

Greenwich.

Seasons, 1876–77.	Pressure.	Temperature.		Tension of Vapour.	Humidity.	Rainfall.		Cloud 0–10.
		Mean.	Daily Range.			Total.	Days.	
	ins.	°	°	in.	%	ins.		
Winter	29·754	43·4	9·9	·245	85	11·90	64	7·3
Spring	29·797	45·0	15·5	·232	75	6·80	48	6·5
Summer.....	29·936	61·3	21·4	·384	71	6·00	37	5·4
Autumn.....	29·932	49·0	16·1	·265	81	6·20	43	5·8

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Results of Meteorological Observations taken at Watford in 1877.

Months.	Pressure of the Atmosphere.	Temperature of the Air.										Humidity of the Air.		
		9 a.m.	Means of		Adopted Mean.	Mean Daily Range.	Absolute Min. and Max.				Absolute Range.	Tension of Vapour.	Dryness.	Relative Humidity.
			Min.	Max.			Min.	Day.	Max.	Day.				
	ins.	°	°	°	°	°	°		°		°	ins.	°	°
January	29·837	41·0	37·6	47·0	41·9	9·4	26·6	21st	55·5	19th	28·9	·241	1·6	94
February	29·948	42·2	39·0	47·7	43·0	8·7	24·7	28th	55·7	7th	31·0	·238	3·1	89
March	29·757	39·8	33·2	46·4	39·8	13·2	20·6	1st	54·3	29th	33·7	·207	4·4	84
April	29·789	45·4	37·0	51·1	44·5	14·1	32·3	24th	60·1	4th	27·8	·237	6·5	78
May	29·892	49·6	40·0	55·4	48·3	15·4	23·6	8th	63·1	26th	39·5	·257	8·6	73
June	30·029	60·9	49·3	73·6	61·3	24·3	42·1	24th	79·4	29th	37·3	·366	10·5	69
July	29·930	60·4	49·5	64·2	58·0	14·7	43·9	8th	80·9	31st	37·0	·388	8·4	74
August	29·891	61·1	50·9	66·3	59·4	15·6	37·0	24th	74·0	6th	43·0	·421	6·9	78
September	30·050	53·2	44·6	60·9	52·9	16·3	32·5	25th	67·6	10th	35·1	·325	6·0	80
October	30·026	48·1	39·0	56·5	47·9	17·5	23·0	18th	66·3	14th	43·3	·290	3·9	86
November	29·663	43·0	36·4	50·7	43·4	14·3	28·0	4th	56·4	5th	28·4	·242	3·3	88
December	30·055	38·8	35·4	45·1	39·8	9·7	25·0	15th	52·3	6th	27·3	·214	2·5	91
Year	29·906	48·6	41·0	55·4	48·4	14·4	20·6	Mar. 1	80·9	July 31	60·3	·285	5·3	82

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Results of Meteorological Observations taken at Watford in 1877—(*continued*).

Months.	Rainfall.					Cloud.			Wind.									
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount 0–10.	No. of days of		Mean Force 0–12.	Number of days of								
	Ins.	Ins.	Date.	Rain or Snow.	Snow only.		Clear Sky.	Overcast.		N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
January	4·93	·70	3rd	27	0	7·0	4	17	2·0	0	1	1	2	6	12	3	3	3
February	1·92	·35	14th	17	3	6·9	2	9	2·2	4	1	0	0	1	7	9	5	1
March	2·67	·33	29th	22	6	6·3	3	10	2·3	5	2	3	2	3	7	4	3	2
April	2·79	·45	9th	17	0	7·2	0	16	2·7	3	5	6	5	4	1	2	4	0
May	2·42	·52	16th	16	0	7·4	2	13	2·4	4	8	3	2	2	5	3	4	0
June	1·26	·33	30th	8	0	5·0	6	4	2·2	4	3	3	2	3	5	5	2	3
July	2·99	·66	14th	14	0	6·1	2	10	1·2	1	0	0	0	3	10	12	4	1
August	3·66	1·11	21st	20	0	5·9	1	8	2·1	4	0	0	1	2	15	3	5	1
September	·85	·21	14th	8	0	6·3	3	12	1·7	5	4	2	2	3	1	3	6	4
October	1·91	·52	29th	13	0	5·0	10	8	1·8	1	1	3	0	2	10	7	3	4
November	4·22	·85	11th	22	0	6·1	4	11	1·6	0	0	0	1	4	13	4	6	2
December	2·14	·62	28th	19	3	6·7	3	14	1·3	2	2	0	0	6	9	5	5	2
Year	31·76	1·11	Aug.21	203	12	6·3	40	132	2·0	33	27	21	17	39	95	60	50	23

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Notes on the months of January and February are given in my report on the year ending 28th February,* and on the months of March to August in my report for the half-year ending 31st August.† In the following notes on the months of September to December, the two principal meteorological elements, temperature and rainfall, will alone be alluded to.

SEPTEMBER.—At the commencement of the month the weather became cooler and drier than it had been in August, and it continued so with the exception of one warm period of seven days, 9th to 15th, of which the mean temperature was 58°·6, being 5°·7 above the mean of the month. After 20th it became cooler than before. Of the small rainfall, 0·74 in. fell during the first half, and 0·11 in. during the last half of the month, and of this only 0·01 in. fell after 18th (on 23rd), no more falling until 7th October, there thus being a period of 18 days with only 0·01 in. of rain.

OCTOBER.—The colder weather which commenced on 21st Sept. continued during the month, with the exception of three rather warm days, 13th (mean 53°·2), 14th (mean 55°·7), and 22nd (mean 55·4). There was one very cold day, 18th (mean 35°·4) with min. 9°·0 below freezing-point, and the min. was below 32° on 4 other days. Of the rainfall, 0·39 in. fell up to 21st, and 1·52 in. from 22nd. The only days without rain for the last 10 days of the month were 26th and 31st.

NOVEMBER.—The weather was but little colder than during the previous month, until the last week (24th to 30th), the mean of which was 41°·0, being 2°·4 below the mean of the month. There was one very warm day, 16th (mean 53°·5). The min. was below 32° on 9 days. The weather was wet throughout the month, the only period of more than one day without rain being 16th to 18th. During the first half of the month 1·84 in. of rain fell, and during the last half 2·38 ins.

DECEMBER.—For the first nine days the weather was rather warmer than during the last week in November, the mean temperature for this period being 41°·7. It then became colder, and continued so with the exception of 12th (mean 43°·8), 17th (mean 44°·5), 22nd (mean 44°·0) and 30th (mean 47°·0). The only very cold period was 25th to 28th, the mean of which was 32°·4, being 7°·4 below the mean of the month. The min. was below 32° on 13 days. The rainfall was distributed equably over the month; there were two periods of 3 days, two of 2 days, and three of 1 day without rain. The max., 0·62 in. on 28th, was partly snow and partly rain.

* 'Trans. Watford Nat. Hist. Soc.,' Vol. I, p. 117.
† *Ib.*, Vol. II, p. 91.

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XXV.

METEOROLOGICAL OBSERVATIONS TAKEN AT THROCKING, HERTS, DURING THE YEAR 1886.

By the Rev. C. W. Harvey, M.A., F.R.Met.Soc.

Read at Hoddesdon, 3rd November, 1887.

Station.—*Position*, Lat. 51° 57′ N., Long. 0° 3′ W. *Height*, 484 feet above sea-level. The position of the instruments, and time of observing, are precisely the same as in 1885.

The following table shows how far Pressure, Temperature, and Rainfall in 1886 differed from the mean for the whole period during which observations have been made, *viz.* the seven years 1880–86.

Months.	Pressure.		Temperature.		Rainfall.	
	Mean 1880–86.	Diff. 1886.	Mean 1880–86.	Diff. 1886.	Mean 1880–86.	Diff. 1886.
January	30·03	−0·41	35·3	−1·6	1·43	+1·06
February	29·90	+0·21	38·8	−7·0	2·26	−2·02
March	29·99	+0·05	40·9	−2·7	1·01	+0·64
April	29·89	+0·05	45·2	−0·4	1·83	−0·50
May	29·99	−0·08	50·6	−0·6	1·17	+3·46
June	29·95	−0·01	56·5	−0·8	1·96	−1·55
July	29·96	=	60·7	+0·2	2·74	−0·37
August	29·99	−0·02	59·6	+1·2	2·10	−0·76
September	29·94	+0·11	56·0	+1·4	2·71	−1·53
October	29·89	−0·13	47·3	+3·0	3·45	−0·35
November	29·93	−0·13	42·0	+0·4	2·60	+0·61
December	29·90	−0·25	37·7	- 2·8	2·26	+1·03
Year	29·94	−0·06	47·5	−0·7	25·52	−0·28

From this table it appears that on the whole 1886 was a very average year. February was very cold but very dry, May was very wet, whilst October was more than usually warm.

Pressure. — The most important depressions were those of October 16th and December 9th; on the former date the mercury stood at 28·65 ins., on the latter it was as low as 28·36 ins.; this is the minimum point reached in the period covered by my observations, and makes the range for 1880–86, 2·58 ins.; *i.e.* from 30·94 ins. on Jan. 18th, 1882, to 28·36 ins. on Dec. 9th, 1886.

Temperature.—The total range of temperature for the year was 69°·3, *i.e.* between 15°·6 on Jan. 8th, and 84°·9 on August 31st. This is a greater range than in any previous year since 1881. The deficiency in the temperature was rather more observable in the day than in the night temperatures, the one being 0°·9, the other only 0°·7 below the mean. The highest maxima and lowest minima were:

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Results of Meteorological Observations taken at Throcking Rectory, Buntingford, in 1886.

Months.	Pressure of the Atmosphere.	Temperature of the Air.									Accumulated Temperature for Month.		Accumulated Temperature since Jan. 1.	
		Means of		Adopted Mean.	Mean Daily Range.	Absolute Min. and Max.				Absolute Range.				
		Min.	Max.			Min.	Date.	Max.	Date.		Above 42°	Below 42°	Above 42°	Below 42°
	ins.	°	°	°	°	°		°		°	°	°	°	°
January	29·62	29·0	38·1	33·7	9·1	15·6	8th	51·6	2nd	36·0	*nil*	257	*nil*	257
February	30·11	27·8	35·9	31·8	8·1	21·1	9th	43·4	13th	22·3	*nil*	330	*nil*	587
March	30·04	32·4	44·4	38·2	12·0	19·2	7th	60·4	21st	41·2	29	152	29	739
April	29·94	37·1	53·3	44·8	16·2	28·4	30th	65·2	24th	36·8	171	61	200	800
May	29·91	42·6	60·5	50·0	17·9	30·2	2nd	75·5	6th	45·3	248	*nil*	448	800
June	29·94	47·2	65·6	55·7	18·4	36·9	5th	75·3	28th	38·4	411	*nil*	859	800
July	29·96	52·4	70·6	60·9	18·2	42·9	28th	84·4	4th	41·5	585	*nil*	1444	800
August	29·97	52·5	70·3	69·8	17·8	43·4	3rd	84·9	31st	41·5	582	*nil*	2026	800
September	30·05	50·3	65·3	57·4	15·0	41·9	23rd	82·9	1st	41·0	462	*nil*	2488	800
October	29·76	43·3	57·8	50·3	14·5	38·9	14th	76·9	4th	38·0	257	*nil*	2745	800
November	29·80	37·6	47·3	42·4	9·7	30·9	8th	56·4	1st	25·5	67	78	2812	878
December	29·65	30·0	39·0	34·9	9·0	20·4	22nd	51·6	6th	31·2	*nil*	220	2812	1098
Year	29·88	40·2	54·0	46·8	13·8	15·6	Jan. 8	84·9	Aug. 31	69·3	—	—	2812	1098

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RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT THROCKING RECTORY, BUNTINGFORD, IN 1886 *(continued)*.

MONTHS.	RAINFALL.					CLOUD.			WIND.									
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount, 0-10.	No. of days of		Mean Force, 0-12.	Number of days of								
	Ins.	Ins.	Date.	Rain or Snow.	Snow only.		Clear Sky.	Overcast.		N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm.
January....	2·49	·24	31st	15	7	7·0	6	18	2·3	3	1	0	5	3	8	4	7	0
February	·24	·08	12th	5	1	7·0	3	17	1·8	5	6	4	1	4	1	2	4	1
March	1·65	·26	17th	12	6	7·7	4	20	3·0	3	3	5	5	2	10	2	1	0
April	1·33	·33	7th	14	3	6·1	3	8	3·0	2	7	3	3	1	8	1	4	1
May	4·63	1·10	24th	21	0	2·9	3	9	2·1	3	3	3	2	6	8	3	2	1
June	·41	·10	22nd	9	0	5·8	2	7	2·3	9	1	3	2	1	3	3	7	1
July	2·37	·74	25th	14	0	5·8	6	7	2·3	7	0	1	1	4	7	7	4	0
August	1·34	·20	18th	11	0	6·5	4	13	2·9	6	2	2	2	2	9	4	4	0
September	1·18	·39	10th	7	0	7·1	3	14	2·6	4	8	3	0	7	5	3	2	0
October	3·10	·49	15th	17	0	6·3	6	16	2·1	2	1	4	6	5	8	2	3	0
November	3·21	·69	10th	12	0	6·8	5	13	1·6	4	2	1	1	7	8	1	5	1
December	3·29	·91	26th	16	2	5·6	9	11	2·8	8	0	0	1	4	8	4	5	1
Year	25·24	1·10	May 24	166	19	6·8	54	153	2·4	56	34	27	29	46	83	36	48	6

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Results of Meteorological Observations taken at Throcking Rectory, Buntingford, in 1886.

Months.	Pressure of the Atmosphere.	Temperature of the Air.									Accumulated Temperature for Month.		Accumulated Temperature since Jan. 1.	
		Means of		Adopted Mean.	Mean Daily Range.	Absolute Min. and Max.				Absolute Range.	Above 42°	Below 42°	Above 42°	Below 42°
		Min.	Max.			Min.	Date.	Max.	Date.					
	ins.	°	°	°	°	°		°		°	°	°	°	°
January	29·62	29·0	38·1	33·7	9·1	15·6	8th	51·6	2nd	36·0	*nil*	257	*nil*	257
February	30·11	27·8	35·9	31·8	8·1	21·1	9th	43·4	13th	22·3	*nil*	330	*nil*	587
March	30·04	32·4	44·4	38·2	12·0	19·2	7th	60·4	21st	41·2	29	152	29	739
April	29·94	37·1	53·3	44·8	16·2	28·4	30th	65·2	24th	36·8	171	61	200	800
May	29·91	42·6	60·5	50·0	17·9	30·2	2nd	75·5	6th	45·3	248	*nil*	448	800
June	29·94	47·2	65·6	55·7	18·4	36·9	5th	75·3	28th	38·4	411	*nil*	859	800
July	29·96	52·4	70·6	60·9	18·2	42·9	28th	84·4	4th	41·5	585	*nil*	1444	800
August	29·97	52·5	70·3	69·8	17·8	43·4	3rd	84·9	31st	41·5	582	*nil*	2026	800
September	30·05	50·3	65·3	57·4	15·0	41·9	23rd	82·9	1st	41·0	462	*nil*	2488	800
October	29·76	43·3	57·8	50·3	14·5	38·9	14th	76·9	4th	38·0	257	*nil*	2745	800
November	29·80	37·6	47·3	42·4	9·7	30·9	8th	56·4	1st	25·5	67	78	2812	878
December	29·65	30·0	39·0	34·9	9·0	20·4	22nd	51·6	6th	31·2	*nil*	220	2812	1098
Year	29·88	40·2	54·0	46·8	13·8	15·6	Jan. 8	84·9	Aug. 31	69·3	—	—	2812	1098

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RESULTS OF METEOROLOGICAL OBSERVATIONS TAKEN AT THROCKING RECTORY, BUNTINGFORD, IN 1886 *(continued)*.

MONTHS.	RAINFALL.					CLOUD.			WIND.										
	Total Fall.	Max. fall in 24 hours.		No. of days of		Mean Amount, 0-10.	No. of days of		Mean Force, 0-12.	Number of days of									
	Ins.	Ins.	Date.	Rain or Snow.	Snow only.		Clear Sky.	Over-cast.		N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm.
January....	2·49	·24	31st	15	7	7·0	6	18	2·3	3	1	0	5	3	8	4	7	0
February	·24	·08	12th	5	1	7·0	3	17	1·8	5	6	4	1	4	1	2	4	1
March	1·65	·26	17th	12	6	7·7	4	20	3·0	3	3	5	5	2	10	2	1	0
April	1·33	·33	7th	14	3	6·1	3	8	3·0	2	7	3	3	1	8	1	4	1
May	4·63	1·10	24th	21	0	2·9	3	9	2·1	3	3	3	2	6	8	3	2	1
June	·41	·10	22nd	9	0	5·8	2	7	2·3	9	1	3	2	1	3	3	7	1
July	2·37	·74	25th	14	0	5·8	6	7	2·3	7	0	1	1	4	7	7	4	0
August	1·34	·20	18th	11	0	6·5	4	13	2·9	6	2	2	2	2	9	4	4	0
September	1·18	·39	10th	7	0	7·1	3	14	2·6	4	8	3	0	7	5	3	2	0
October	3·10	·49	15th	17	0	6·3	6	16	2·1	2	1	4	6	5	8	2	3	0
November	3·21	·69	10th	12	0	6·8	5	13	1·6	4	2	1	1	7	8	1	5	1
December	3·29	·91	26th	16	2	5·6	9	11	2·8	8	0	0	1	4	8	4	5	1
Year	25·24	1·10	May 24	166	19	6·8	54	153	2·4	56	34	27	29	46	83	36	48	6

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Highest Maxima.		Lowest Minima.	
(*a*) Aug. 31st	84°·9	(*a*) Jan. 8th	15°·6
(*b*) July 4th & Aug. 30th	84 ·4	(*b*) March 7th	19 ·2
(*c*) „ 3rd	83 ·9	(*c*) Dec. 18th	20 ·4
(*d*) „ 6th	83 ·4	(*d*) March 11th	20 ·3

The minima for March were very low indeed for the time of year. It is notable that the last day of the last of the summer months should have proved the hottest.

The maximum in the sun and the minimum on the grass for each month was as follows:—

	Max. in Sun. °	Min. on Grass. °		Max. in Sun. °	Min. on Grass. °
Jan.	86·6	?	July	140·4	42·3
Feb.	92·5	15·0	Aug.	130·8	40·9
March	107·9	15·0	Sept.	127·0	38·9
April	115·9	24·9	Oct.	120·5	35·9
May	156·0	24·9	Nov.	94·8	26·9
June	132·5	36·9	Dec.	74·8	20·4

Rainfall.—The fall was very evenly divided between the day and the night, for whilst 12·29 inches fell during the day, 12·95 fell at night.

Distribution of Rainfall.—Winter 23°/₀; Spring 30°/₀; Summer 17°/₀; Autumn 30°/₀. *Chief falls.*—May 24th 1·10; May 12th 1·00; Dec. 26th 0·91 (snow); July 25th 0·74; Nov. 10th 0·69; May 22nd 0·68; Nov. 11th 0·67; Nov. 5th 0·62. *Partial droughts* (28 *days during which the fall did not exceed* 0·25 *in.*)—Feb. 1st—28th, fall 0·24 in.; June 13th—July 10th, fall 0·23 in. *Absolute droughts* (14 *days without rain*).—June 23rd—July 10th, 18 days; Sept. 11th—24th, 14 days.

The following table gives the particulars of the seasons:—

Seasons, 1885–86.	Mean Pressure.	Mean Temperature.	Mean Daily Range.	Accumulated Temperature.		Rainfall.
				Above 42°.	Below 42°.	
	ins.	°	°	°	°	ins.
Winter	29·94	34·1	9·0	*nil*	745	3·55
Spring	29·96	44·3	15·4	448	213	7·61
Summer	29·96	59·1	18·1	1578	*nil*	4·12
Autumn	29·87	50·0	13·1	786	78	7·49

Winter was the driest and coldest, Spring the wettest, Summer the driest except in 1885, and Autumn the warmest yet observed.

I conclude with a very brief summary of the months.

January.—A cold month, with frequent falls of snow; the rainfall being the largest yet recorded, and the mean pressure being at the same time the lowest.

February.—The coldest and the driest yet observed, the fall of rain being smaller than in any previous month, less even than Jan. 1880 (0·26); 11th to 13th one continuous thick fog. Coldest Feb. since 1857.

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MARCH.—A cold month, especially for the first fortnight, when mean temperature was only 30°·3, or about 11° below the average. The rainfall was the largest yet recorded for the month. The snow which fell at the commencement of the month lay until 19th. On 15th the ice on ponds was quite thick, the daily papers recording 5 inches of ice on the Serpentine.

APRIL.—A bright month, little rain falling after 18th. On 10th and 11th snow fell in large flakes for a short time; on 18th thick fog.

MAY.—An exceedingly wet month, probably the wettest May since 1878. The first week, however, was perfectly dry. In the last three weeks upwards of four times the usual monthly fall was gauged. On 17th a strong wind did much damage to fruit-trees in blossom. On 19th thunder, and on 23rd a thunder-storm.

JUNE.—The driest June yet observed. Sharp frost on June 4th. After 23rd the weather became very bright, and much warmer.

JULY.—The bright weather of the latter part of June lasted until 11th, after which rain was somewhat frequent.

AUGUST.—A fine month, no rain falling from 3rd to 8th, or after 19th. Towards the end of the month the weather became hot.

SEPTEMBER.—A very fine month. For the first time in my observations the temperature has exceeded 80° in September, reaching 82°·9 on 1st. The rainfall was less than in any previous year. I am sorry to have to record the discovery of an omission of 0°·39 of rain on Sept. 10th, which makes the monthly fall given in my Herts tables, and the yearly fall in 'British Rainfall,' too little by that amount.

OCTOBER.—The fall of rain was considerable, but not above the average, the October fall as a rule being the heaviest in the year. It was the warmest October (except that of 1883) yet observed, the temperature for the first time exceeding 70°, being 76°·9 on 4th.

NOVEMBER.—A very average month as regards rainfall. With the exception of 1881, the warmest on record.

DECEMBER.—A bright month, though rain was by no means unfrequent. The snowstorm of 26th was a very sudden, and a very heavy one, and probably owing to the peculiar wetness of the snow, which made it very sticky, it did considerable damage to telegraph posts, etc.

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XXVI.

REPORT ON THE RAINFALL IN HERTFORDSHIRE IN 1886.

By the Rev. C. W. Harvey, M.A., F.R.Met.Soc.

Read at Hoddesdon, 3rd November, 1887.

The number of gauges, and our staff of observers, remain exactly the same as last year, and I am aware of no change in the position of any of the gauges. I have compared the rainfall for 1886 with the rainfall of the previous ten years, 1876–85, using the same set of means as last year. The terms "*mean*" and "*average*" will therefore again refer to this ten-year period.

The fall for the present year proves to be smaller than that of any of the previous ten, with the exception of 1883 and 1884, but the number of wet days was slightly above the average.

Distribution of Rainfall throughout the Year.—Of the total rainfall 38% fell during the winter months, 14% during the spring, 28% during the summer, and 20% during the autumn. The fall of each quarter, and of each season, and how far it differed from the mean, was as follows:

	Fall.	Diff.		Fall.	Diff.
1st quarter.....	5·32 in.	— ·69 in.	Winter	10·57 in.	+3·42 in.
2nd ,, ...	7·09	+ ·45 in.	Spring	3·79	—1·95
3rd ,, ...	4·36	—3·84	Summer	7·59	— ·13
4th ,, ...	10·73	+2·58	Autumn	5·55	—2·84
	27·50	—1·50		27·50	—1·50

Thus the winter fall was most in excess of the mean, whilst the autumn fall showed the greatest deficiency.

A comparison of the monthly fall with the mean shows that May was the wettest month and February the driest; January and December showed a considerable excess, whilst June, August, and September showed a corresponding deficiency.

	ins.		ins.		ins.		ins.
Jan.	+ 1·20	April.....	— ·56	July	— ·33	Oct.	+ ·61
Feb.	— 1·93	May	+2·50	Aug.	—1·68	Nov.....	+ ·19
Mar.	+ ·04	June.....	—1·49	Sept.....	—1·83	Dec.....	+1·78

Distribution of Rainfall throughout the County.—In each of the river-basins of the Thames and the Ouse the fall was just an inch below the mean. In the five districts of the Thame, Colne, Lea, Ivel, and Cam, the Thame alone showed any excess, and that very slight, whilst the Colne showed a considerable deficiency. The mean fall in each of these districts was—

		ins.			ins.
Lea	Lower Lea.....	29·47	Thame.....	Upper Thame	32·01
	Upper Lea.....	25·36		Lower Colne	29·82
	Mimram.....	27·24	Colne	Ver.....	28·26
	Beane.....	28·66		Gade	29·25
	Rib.....	25·88	Ivel	Hiz.....	26·43
	Ash	26·47	Cam.....	Rhee	23·40

The total yearly fall ranged from 32·79 ins. at Moor Park, to 22·33 ins. at Odsey; whilst the monthly fall ranged from 6·31 ins. at Tring in December, to 0·23 in. at Odsey in February.

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The absolute maximum daily fall in each month and the station recording the same was—

	ins.		ins.
Jan. 5th—Southgate	·60	July 25th—Therfield	1·09
Feb. 2nd—Southgate	·45	Aug. 1st—Royston	·35
Mar. 28th—Moor Park	·46	Sept. 2nd—Bayfordbury	·61
April 7th—Moor Park	·76	Oct. 31st—Nash Mills	·76
May 24th—Southgate	1·70	Nov. 5th—Tring	1·04
June 10th—Nash Mills	·70	Dec. 26th—Tring	2·04

From this it appears that the maximum fall in the year was 2·04 ins. on Dec. 26th, the date of the heavy snowstorm and gale, when at most stations the fall exceeded an inch, the mean fall being 1·20 in. The wettest day in each month was—

Jan. 5th at 12 stations; 10th at 2; 11th at 1; 20th at 2; 22nd at 1; 24th at 2; 30th at 3; 31st at 1; the fall on 12th and 25th being the same at 1.

Feb. 2nd at 8; 3rd at 7; 5th at 1; 12th at 3; 14th at 5; 28th at 1.

March 1st at 12; 17th at 1; 28th at 4; 29th at 4; 30th at 1; the 1st and 19th, 19th and 30th, and 1st and 28th being respectively the same at 3.

April 7th at 18; 18th at 5; 19th at 1; 7th and 18th being the same at 1.

May 12th at 15; 24th at 9; the 12th and 24th being equal at 1.

June 1st at 3; 2nd at 11; 10th at 7; 12th at 3; 22nd at 1.

July 2nd at 1; 12th at 1; 19th at 2; 25th at 20; the fall of 17th and 25th being the same at 1.

Aug. 1st at 3; 12th at 12; 13th at 6; 18th at 4.

Sept. 2nd at 12; 3rd at 1; 9th at 1; 10th at 9; 2nd and 10th being equal at 2.

October 12th at 9; 15th at 12; 31st at 3; 12th and 15th being the same at 1.

November 5th at 13; 10th at 2; 11th at 9; 13th at 1.

December 26th at all stations.

From this the wettest day in each month seems to have been—

Jan. 5th.	Apr. 7th.	July 25th.	Oct. 15th.
Feb. 2nd.	May 12th.	Aug. 12th.	Nov. 5th.
Mar. 1st.	June 2nd.	Sept. 2nd.	Dec. 26th.

The mean number of wet days in each month, and the relation that number bears to the mean of the month, was—

Jan.	wet days	22 or 6 above mean.	July	wet days	12 or 1 below mean.
Feb.	,,	8 or 7 below ,,	Aug.	,,	11 or 3 below ,,
Mar.	,,	15 or 1 above ,,	Sept.	,,	8 or 5 below ,,
Apr.	,,	15 or 2 above ,,	Oct.	,,	21 or 7 above ,,
May	,,	19 or 6 above ,,	Nov.	,,	15 or 1 below ,,
June	,,	9 or 5 below ,,	Dec.	,,	17 or 2 above ,,

The total number of wet days was thus 2 above the mean, being very equally distributed throughout each of the seasons except the summer, 47 occurring in winter, 49 in spring, 32 in summer, and 44 in autumn.

I now conclude my report with a brief notice of the chief falls; but in order as much as possible to economise space I am obliged to confine my remarks to falls which exceed an inch, using the same nomenclature as in my previous reports, viz. falls of 1 inch *great*; falls of 1¼ inch *very great*; falls of 1½ inch *heavy*; falls of 1¾ inch *very heavy*; falls of 2 inches *excessive*. Falls of ½ inch and ¾ inch, which I have styled *considerable* and *very considerable*, I can only merely note in passing, without giving the actual values at each station.

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Table I.—Hertfordshire Rainfall Stations.

River District.	Station.	Observer.	Latitude.	Longitude.	Diameter of Gauge.	Height of Gauge above Ground.	Height of Gauge above Sea-level.	
			° ′ ″	° ′ ″	ins.	ft. ins.	ft.	
Thame — Up. Thame	Tring—The Vicarage	Rev. W. Quennell	11 17 33 N	0 39 21 W	1	1 0	112	T
Colne — Lower Colne	Watford—Watford House	Alfred T. Brett, M.D.	11 39 21 N	0 23 31 W	1	1 0	210	T
	,, Wansford House	John Hopkinson	11 39 41 N	0 23 10 W	1	1 0	221	T
	Rickmansworth—Moor Park	Lord Ebury	11 37 30 N	0 26 20 W	1	2 0	310	⅄
Colne — Ver	St. Albans—Gorhambury	The Earl of Verulam	11 11 20 N	0 23 0 W	6	2 6	121	
	Harpenden—Rothamsted	Sir J. B. Lawes and Dr. Gilbert	11 18 10 N	0 21 30 W	1	0 9	120	T
	,, ,, (2nd gauge)		11 18 10 N	0 21 30 W	72 × 87	0 9	620	T
	,, ,, (3rd gauge)		11 18 10 N	0 21 30 W	8	0 9	220	T
	Kensworth	Miss Grace Jones	11 11 30 N	0 30 0 W	1	1 1	130	B
Colne — Gade and Bulbourne	Hemel Hempsted—Nash Mills	J. Dickinson & Co.	11 11 0 N	0 26 10 W	12	3 9	137	T
	,, Great Gaddesden	Rev. W. T. Drake	11 17 20 N	0 30 30 W	8	1 0	326	⅄
	Berkhamsted	Edward Mawley	11 11 10 N	0 33 30 W	8	1 0	201	⅄
	Tring—Cowroast	Hubert Thomas, C.E.	11 17 0 N	0 36 30 W	10	1 2	110	L
Lea — Lower Lea	East Barnet—Southgate	G. A. Church	11 37 10 N	0 8 0 W	1	0 6	213	T
Lea — Upper Lea	Ware—New River Company	F. Francis, C.E.	11 16 0 N	0 6 0 W	12	3 0	210	T
	,, Fanhams Hall	Miss J. Croft	11 19 30 N	0 1 30 W	1	1 0	228	
	Hertford—Bayfordbury	W. Clinton Baker	11 16 30 N	0 1 30 W	8	0 1	386	
Lea — Mimram	Welwyn—The Rectory	Rev. C. L. Wingfield	11 19 10 N	0 12 30 W	8	0 1	180	T
	,, Datchworth	Rev. J. Wardale	11 11 0 N	0 10 0 W	6	1 0	111	T
Lea — Beane	Stevenage—Bennington	Rev. J. D. Parker, LL.D.	11 13 11 N	0 1 20 W	1	1 0	111	⅄
	,, Knebworth	Rev. F. G. Jenyns	11 12 30 N	0 12 30 W	1	1 0	391	⅄
Lea — Rib	Buntingford—Throcking	Rev. C. W. Harvey	11 17 1 N	0 3 0 W	1	1 0	181	T
	Therfield	Rev. J. G. Hale	12 1 0 N	0 3 0 W	1	1 3	100	
Lea — Ash	Much Hadham	T. W. Mott	11 11 21 N	0 1 38 E	1	1 0	222	B
Cam Ivel — Hiz	Hitchin	William Lucas	11 17 0 N	0 16 20 W	1	2 1	238	⅄
	,, High Down	Joseph Pollard	11 17 10 N	0 20 0 W	1	1 1	122	⅄
Cam Ivel — Rhee	Royston	H. Wortham	12 2 31 N	0 1 8 W	8	0 6	269	⅄
	,, Odsey Grange	H. G. Fordham	12 1 28 N	0 6 11 W	1	1 0	263	⅄
	,, ,, (2nd gauge)	,, ,,	12 1 28 N	0 6 41 W	1	1 0	263	⅄

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TABLE II.—RAINFALL AT VARIOUS STATIONS IN HERTFORDSHIRE IN 1886.

STATIONS.	JAN.	FEB.	MAR.	APL.	MAY.	JUNE.	JULY.	AUG.	SEPT.	OCT.	NOV.	DEC.	TOTAL.	DAYS.
*Tring—The Vicarage	3·90	·87	1·68	1·81	4·09	1·62	1·92	·94	1·33	4·02	3·52	6·31	32·01	175
*Watford—Wansford House	3·63	·82	1·87	1·85	4·43	1·46	2·08	·96	1·98	3·61	2·72	4·50	29·91	187
,, Watford House	3·24	·75	1·74	1·70	4·29	1·52	1·91	·77	1·97	2·92	2·31	3·65	26·77	177
*Rickmansworth—Moor Park	3·86	·87	2·39	2·44	5·07	1·17	2·43	·99	2·23	3·80	3·01	4·51	32·77	184
St. Albans—Gorhambury ..	3·29	·54	1·41	1·85	4·26	·94	2·29	1·06	1·11	4·15	2·69	3·64	27·73	144
Harpenden—Rothamsted ..	2·80	·55	1·44	1·88	4·16	1·15	2·38	1·13	1·43	3·91	2·71	4·17	27·71	180
* ,, ,, (2nd gauge)	3·44	·61	1·59	1·96	4·24	1·23	2·42	1·22	1·51	3·94	2·77	4·21	29·14	200
,, ,, (3rd gauge)	2·95	·55	1·42	1·83	4·08	1·14	2·31	1·12	1·38	3·77	2·62	4·12	27·29	176
*Kensworth	3·33	·70	1·38	2·03	4·24	1·73	1·75	·95	1·28	3·99	3·33	4·16	28·87	152
*Hml. Hempsted—Nash Mills	3·25	·56	1·70	1·80	4·50	1·33	2·10	·96	1·53	4·42	2·57	4·39	29·11	156
* ,, Great Gaddesden	3·57	·65	1·57	1·82	3·95	1·27	1·77	·86	1·68	3·63	2·84	4·31	27·92	175
*Berkhamsted—Rose Bank ..	3·94	·83	1·62	1·50	3·85	1·35	1·88	·95	1·52	3·57	2·81	5·27	29·09	171
*Tring—Cowroast	4·06	·68	1·83	1·76	3·84	1·49	1·65	·94	1·72	3·97	3·37	5·59	30·90	143
*East Barnet Southgate ..	4·01	·90	1·69	1·43	5·20	·39	2·87	·82	1·26	3·75	3·47	3·68	29·47	176
Ware—New River Company	2·89	·31	1·43	1·48	4·52	·33	2·26	·87	1·36	2·75	2·73	3·29	24·22	146
* ,, Fanhams Hall.....	2·99	·48	1·56	1·69	4·81	·40	2·35	·96	1·30	2·45	2·82	3·78	25·59	173
Hertford—Bayfordbury.....	3·27	·37	1·71	1·30	4·26	·37	2·05	·94	1·57	3·40	2·79	4·23	26·26	171
*Welwyn—The Rectory	3·88	·41	1·46	2·11	4·32	1·00	2·44	1·19	1·35	3·46	2·39	3·75	27·76	175
,, Datchworth	3·16	·37	1·51	1·95	4·61	·70	2·43	1·00	1·31	3·10	2·90	3·68	26·72	190
*Stevenage—Bennington.....	3·27	·31	1·57	1·76	5·16	·40	2·65	1·09	1·44	2·95	3·25	4·39	28·24	189
,, Knebworth	3·37	·46	1·61	2·04	4·84	·90	2·27	1·26	1·49	3·73	3·14	3·98	29·09	185
*Buntingford—Throcking ...	2·49	·24	1·65	1·33	4·63	·41	2·37	1·34	1·18	3·10	3·21	3·29	25·24	166
*Therfield	2·82	·31	1·60	1·45	5·06	·68	2·71	1·56	1·18	3·21	3·07	2·87	26·52	154
*Much Hadham	3·25	·26	1·61	1·51	4·12	·47	2·45	1·09	1·35	2·54	3·29	4·53	26·47	162
Hitchin	3·10	·40	1·28	1·62	4·09	·94	1·69	1·17	1·25	3·65	3·21	4·20	26·60	179
,, High Down	3·05	·59	1·51	1·56	4·06	1·12	1·56	1·32	1·31	3·18	3·13	3·88	26·27	166
*Royston	2·46	·30	1·50	1·21	4·55	·67	2·58	1·40	1·12	2·65	2·79	3·89	25·12	156
* ,, Odsey Grange	2·19	·23	1·06	1·46	4·71	·50	2·19	1·18	1·13	2·63	2·74	2·71	22·73	172
,, ,, (2nd gauge)..	2·24	·23	·98	1·37	4·81	·44	2·00	1·18	1·08	2·69	2·50	2·81	22·33	169
Mean for the County	3·23	·52	1·57	1·70	4·45	·94	2·20	1·08	1·08	3·39	2·89	4·45	27·50	172

N.B.—The Gorhambury values were received too late to be computed with the rest. * Denotes that daily fall was sent in by observer.

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Table III.—Mean Monthly Fall in the River Districts.

Month.	Thame.			Colne.			Lea.			Ivel.			Cam.		
	1876–85.	1886.	Diff. 1886.	1876–85.	1886.	Diff. 1886.	1876–85.	1886.	Diff. 1886.	1876–85.	1886.	Diff. 1886.	1876–85.	1886.	Diff. 1886.
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
January	2·36	3·90	+1·54	2·27	3·46	+1·19	1·88	3·22	+1·34	1·80	3·07	+1·27	1·55	2·30	+ ·75
February	2·84	·87	—1·97	2·72	·69	—2·03	2·32	·40	—1·92	2·19	·50	—1·69	1·93	·25	—1·68
March	1·68	1·68	=	1·67	1·69	+ ·02	1·46	1·58	+ ·12	1·28	1·40	+ ·12	1·16	1·18	+ ·02
April	2·32	1·81	— ·51	2·56	1·87	— ·69	2·19	1·64	— ·55	2·30	1·59	— ·71	1·96	1·35	— ·61
May	2·20	4·09	+1·89	2·11	4·24	+2·13	1·82	4·68	+2·86	1·83	4·07	+2·24	1·71	4·69	+2·98
June	2·34	1·62	— ·72	2·64	1·35	—1·29	2·25	·55	—1·70	2·16	1·03	—1·13	2·33	·53	—1·80
July	2·72	1·92	— ·80	2·54	2·06	— ·48	2·50	2·44	— ·06	2·60	1·62	— ·98	2·16	2·26	+ ·10
August	2·83	·94	—1·89	3·19	·99	—2·20	2·69	1·10	—1·59	2·68	1·25	—1·43	2·54	1·25	—1·29
September	3·28	1·33	—1·95	2·82	1·66	—1·16	2·71	1·35	—1·36	2·88	1·28	—1·60	2·49	1·11	—1·38
October	3·11	4·02	+ ·91	2·95	3·78	+ ·83	2·66	3·13	+ ·47	2·58	3·41	+ ·83	2·32	2·66	+ ·34
November	3·45	3·52	+ ·07	3·05	2·82	— ·23	2·89	3·01	+ ·12	2·79	3·17	+ ·38	2·34	2·67	+ ·33
December	2·77	6·31	+3·54	2·78	4·44	+1·66	2·33	3·78	+1·45	2·21	4·04	+1·83	2·01	3·14	+1·13
Year	31·90	32·01	+ ·11	31·30	29·05	—2·25	27·70	26·88	— ·82	27·30	26·43	— ·87	24·50	23·39	—1·11

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JANUARY.—A wintry month, snow falling frequently. On 5th and 30th one station in each case gives the fall as *considerable*.

FEBRUARY.—A cold month with snow upon several occasions; 4th–10th and 15th–27th were dry periods; no fall could be called even *considerable*.

MARCH.—Snow ushered in the month and fell upon several days during the first half of the month. Until 15th the weather was decidedly dry, the last week being as decidedly wet.

APRIL.—The unsettled weather of the end of March continued until 18th, after which there was some improvement. The fall of 7th was *considerable* at several stations and *very considerable* at one.

MAY.—For the first ten days the weather was dry, after which it became thoroughly wet. The fall was *considerable* or *very considerable* on 12th, 21st, 22nd, and 24th. On 12th it was *very great* at Moor Park, 1·25; *great* at Royston, 1·23, Knebworth, 1·18, Nash Mills, 1·17, Berkhamsted, 1·09, Wansford House, 1·04, Tring, 1·03, Ware (Fanhams Hall), Hitchin and Southgate, 1·01, and Cowroast and Welwyn, 1·00. On 24th the fall was *heavy* at Southgate, 1·70; *very great* at Ware (Fanhams Hall) and Therfield, 1·36, Ware (N.R.C.), 1·33, Bennington, 1·28, and Hadham, 1·25; *great* at Bayfordbury, 1·21, Royston, 1·19, Throcking, 1·10, and Odsey, 1·07.

JUNE.—The fall, which was far from large, occurred chiefly on the first two days and between 10th and 13th, after which dry weather set in. On 2nd and 10th it was *considerable* at several stations.

JULY.—The dry period which commenced June 14th lasted until July 12th, after which the weather became unsettled. The fall of 25th was *very considerable* at several stations, being *great* at Therfield, 1·09, and Royston, 1·00. On 23rd the fall was *considerable* at one station and *very considerable* at another.

AUGUST.—Rain was frequent until 11th, and then the weather was dry, rain only falling on 25th–27th. On 2nd and 10th the fall was considerable at some stations.

OCTOBER.—After 5th the month proved wet. On 12th the fall, which was *considerable* at several stations, was *very considerable* on the western side of the county. On 15th the fall proved *considerable* at several stations.

NOVEMBER.—The wet weather of October continued until 16th, after which the fall was slight. On 5th the fall was *considerable* at many stations and *very considerable* at two.

DECEMBER.—The first half of the month was wet, the snowstorm of 26th making it by far the heaviest monthly fall of the year. On 7th, 8th, and 14th the fall was *considerable* at several stations, and *very considerable* at a few. On 26th the fall of snow was *excessive* at Tring, 2·04; *very heavy* at Berkhamsted and Bennington, 1·95; *heavy* at Wansford House, 1·65, Watford House, 1·60, Hadham, 1·52, and Bayfordbury, 1·51; *very great* at Nash Mills, 1·47, Moor Park, 1·35, Royston, 1·34, Welwyn, 1·33, Knebworth, 1·28, and Hitchin, 1·27; *great* at Hitchin (High Down),

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1·18, Rothamsted, 1·15, and Southgate, 1·10. This snowstorm came upon us very suddenly upon the evening of 26th, and the snow being almost twice its usual density the storm did considerable damage, completely paralysing our telegraphic system.

During the year there were four days upon which the fall exceeded an inch at some one or more stations, namely 2 in May, 1 in July, and 1 in December.

As regards droughts, adopting Mr. Symons' definition that an absolute drought is a period of not less than 14 days with no measurable rainfall, we find two such periods, the first being June 23rd to July 10th, or 18 days, at all stations with the following exceptions: Tring, ·02, Berkhamsted, ·01, and Southgate, ·06, on 9th; Ware (Fanhams Hall), ·04, and Hadham, ·01, on 7th; the second period was September 10th to 24th, or 15 days, which was an absolute drought at all stations, lasting at Kensworth from 9th to 25th, or 17 days.

The following table gives the number of rainfall stations and the mean rainfall for 1886 in Herts and in the five adjacent counties of Cambs, Essex, Middlesex, Bucks, and Beds, the values being computed from the yearly totals published in 'British Rainfall.'

County.	Stations.	Mean Fall.	County.	Stations.	Mean Fall.
Herts	25	27·50	Middx	57	26·29
Cambs	29	24·89	Bucks	15	29·50
Essex	34	22·62	Beds	23	26·23

Average Rainfall, 26·17 ins.

The rainfall in Hertfordshire was therefore greater than in any one of the immediately surrounding counties except Buckinghamshire, and was about 5 per cent. above the mean for the whole area embraced by the six counties.

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XXVII.

MISCELLANEOUS NOTES AND OBSERVATIONS.

Read at Watford, 19th April, 1887.

Meteorology.

Fog-Bows at Odsey.—A white Fog-bow was observed here on 16th February, 1887, between half-past nine and ten o'clock in the morning. With a low sun, and a broken fog drifting with the wind, a bow was thrown from time to time on one mass of fog by the sun-light passing through another. It was perfectly white, but never very distinct. There was a sharp frost at the time.

I have also recorded a fog-bow, seen here on 23rd December, 1879, between eleven and twelve o'clock in the morning, in a letter in the 'Meteorological Magazine' for January, 1880 (vol. xiv, p. 192), giving the following particulars: "A low white fog of varying density was driving before a moderate E.S.E. wind, with sun-light occasionally gleaming through it. In these lighter intervals a distinct white bow appeared on the fog in the N.N.W., at a short distance from the observer. This bow varied in clearness, generally in proportion to the amount of sun-light, and in its various parts according to the definiteness of the fog on which it was projected. It was perfectly white, but similar in other respects to a rain-bow. The weather was frosty."

This phenomenon is probably not uncommon, although, as the bow is white and rarely well-defined, it is not often recorded. It may always be looked for in the winter, when the early morning is frosty and foggy, and, after the sun has attained some height in the heavens, the fog is gradually broken up by wind. A number of observations and notes on this subject are collected by Mr. G. J. Symons, F.R.S., in a paper, "On a White Rain or Fog-bow," published in the 'Quarterly Journal of the Meteorological Society' for October, 1875, in which (at p. 443) he cites the following explanation from 'A Treatise on Meteorology,' by Elias Loomis, LL.D. (New York, 1868), p. 214: "If the rain-drops be less than $\frac{1}{77}$th of an inch in diameter, the primary bow will be wider than 2°, the breadth of the bow depending simply upon the size of the drops. But as the breadth of the bow increases, the colours are spread over a greater surface, and consequently they are less vivid and distinct. When the diameter of the drops is $\frac{1}{120}$ of an inch, which is the average diameter of particles of fog, the bow becomes a very faint arch 4° or 5° in breadth, with only a slight rosy tint upon the outside. Such a bow is actually observed when the sun shines upon a dense fog."

[*Postscript, Sept.*, 1887. In the 'Meteorological Magazine' for August, 1887 (vol. xxii, p. 108), the Editor has reprinted from the 'Report of the Marlborough College Nat. Hist. Soc.' for the year ending Christmas, 1886, notes of two white fog-bows seen, the

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one at Poonah in 1855, and the other at Poulton Downs on 10th Feb., 1886. In the latter case the bow was seen with a setting sun.]—*H. George Fordham, Odsey Grange, Royston.*

Botany.

A Nectarine growing on a Peach Tree.—Last autumn Mr. T. Cotterell, of the Stanboroughs, Watford, showed me a nectarine growing on a peach tree on a wall in his garden. There were a peach and a nectarine growing almost from the same stalk and touching each other, yet both perfect in the shape, colour, and flavour of the fruit, and in the stones. I had never seen this before, nor had any of the gardeners of whom I had inquired. In searching through the 'Journal of the Royal Horticultural Society' I find, however, that the same thing was recorded 80 years ago. It was considered sufficiently remarkable to form the subject of a paper, and an illustration was given; and as since then Charles Darwin has furnished us with a key to explain these apparent deviations from the usual course of nature, I thought it might not be a waste of time if I directed your attention to the subject. In the 'Transactions of the Royal Horticultural Society,' 2nd series, vol. i, p. 3, Mr. R. A. Salisbury, F.R.S., says: "Though it has long been known that nectarines and peaches are sometimes naturally produced not only on the same tree, but also on the same branch, I do not find the fact recorded by any author, and having last year met with two instances, I presume to offer a short history of this anomaly." The first instance recorded seems to be in a letter to Linnæus. The writer, after alluding to two apple trees standing near each other, one of which in consequence bore rough and smooth fruits, mentions a peach tree which produced both peaches and nectarines. In the next volume of the 'Transactions' (p. 59) a case is mentioned, in 1812, of a peach and a nectarine growing close to each other on the same tree.

I do not think that this phenomenon is caused by cross-fertilization, because, if it were, I should expect a hybrid to be produced. I should expect a fruit partaking of the nature of both parents—half-peach, half-nectarine. But in our case this did not occur; each fruit was perfect of its kind, in appearance, flavour, and seed. My explanation is that it is a kind of reversion, or what breeders call a "throwing back"; that the peach and the nectarine, however different they are now, are derived from a common stock. The French call the nectarine the smooth peach, and say that accidental varieties have been cultivated that would seem to become distinct species. But in Mr. Cotterell's tree the common origin is showing itself by its producing two different fruits on one twig; and it seems to me that the facts I have recorded help to substantiate the theories of Darwin. One case is recorded of a single fruit partaking of the nature of both peach and nectarine. [*Postscript, Sept.*, 1887. This year the tree has produced the ordinary fruit.]—*A. T. Brett, M.D., Watford.*

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Zoology.

Biography of a Cuckoo.—The captive nursling whose life-history I am about to record, was bought by Mr. W. Wise, of Watford, early in July, 1883, from a person residing at Kingswood, near Leavesden. In all probability it would then be about a month old. Nothing is known respecting its foster-parents, and the place of its birth could not be ascertained. During the months of its infancy, like other tyrants of the nursery, it demanded and received the most continuous and careful attention. It was found necessary to feed it about every fifteen minutes during the day, and many were the kindly visits paid to its cage during the early hours of the morning. Its food at this time consisted of green caterpillars and meal-worms, with hard-boiled eggs and raw beef. It struggled successfully through all the difficulties and vicissitudes of its first year, and, on the 19th of March, 1884, it vindicated its right to its popular name by pronouncing, for the first time, the well-known note "Cuckoo." On the 27th of the same month it called "Cuckoo" at three different times, but it only essayed to call it on five other occasions during the year. In the year 1885 it repeated the word "Cuckoo" on only twelve occasions, commencing on the 26th of March, and closing on the 12th of June. In 1886 it commenced its call on the 28th of February, an unusually early date, and it uttered an occasional note, more or less continuously, during March, April, and May. At the commencement of June it ceased to call, became seriously unwell, and appeared to grow weaker and weaker every day. It was then treated to a liberal supply of cod-liver oil, and the beneficial effect of this restorative was marvellous. In July, when, in accordance with the old adage, it ought to have "prepared to fly," it achieved the triumph of its life; on the 19th, 21st, and 23rd of that month it pronounced the word "Cuckoo" 81 times. It spoke its last word on the 18th of August, and, notwithstanding every possible care and attention, it died in peace, in its wicker cage, on the 29th of December, 1886, at the age of about 3½ years. It was buried on the same day, but was afterwards exhumed and taken to Mr. Bowers for the purpose of being mounted. This was found to be altogether impossible, and the little bird rests at present in Dr. Brett's surgery, where I recently had the opportunity of examining it. During the three and a half years of its existence it consumed on the average four eggs and 1½ pennyworth of raw beef per week.

The task of rearing a young cuckoo in confinement is so extremely difficult, and so very rarely results in success, that I have thought it desirable to give these particulars in detail. I am indebted for them to Dr. A. T. Brett.—*J. E. Littleboy, Hunton Bridge.*

Dogs entrapped while following Rabbits.—I think that an incident which has lately occurred at Moor Park may be fairly placed in the category of natural history. I have never before heard of a similar occurrence. We have at Moor Park three pet fox-terriers, one of

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them an old dog, the other two young ones. About noon, on Sunday, a fortnight ago, they all went out together, but at two o'clock, when we have lunch, and when they all usually appear, only the old one was to be seen. Five o'clock came and still the same state of things continued, and on inquiry being made it was found that no one about the house had seen anything of the two missing dogs. At six, when it was quite dark, one of my sons proceeded to make a search, and, after being out a little while in the old pleasure ground, he thought he heard a sound, which, had he not been on the look-out, he would not have noticed. Proceeding towards the place whence it seemed to come, he heard it again, and at length traced it to one of the old hollow oaks, and there, sure enough, the two dogs were imprisoned. It would appear that they had followed a rabbit through a hole in the bark, at the bottom of the tree, and had made their way up through a quantity of leaves and bits of branches which the jackdaws had brought to use in the making of their nests. The dogs scrambled up after their prey, which continued to escape them, the accumulated rubbish blocked the hole at the bottom, and they were unable to get out again. An axe was procured, a hole sufficiently large was made, and the dogs, although not without some difficulty, were got out of their prison. Now comes the most curious part of the story. Three days afterwards the two dogs again disappeared, and no tidings of them could be obtained; at last, one of the grooms, when taking the horses out for exercise, to his great surprise saw one of them sitting on the fork of a hollow oak tree, about twenty feet from the ground; he being the slimmer of the two had managed to get through a hole too small for the other, whose head was perceived peeping out of it. The second entrapment had come to pass just as on the previous occasion, and the dogs were eventually got down from their perilous position with the help of a ladder.—[*Lord*] *Ebury, Moor Park, 11th Feb.*, 1887.

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APPENDIX.

LIST OF MEMBERS

OF THE

HERTFORDSHIRE NATURAL HISTORY SOCIETY AND FIELD CLUB.

FEBRUARY, 1888.

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1881-83. GEORGE ROOPER, F.Z.S.
1883-85. RIGHT HONOURABLE EARL COWPER, K.G.
1885-87. PROF. JOHN ATTFIELD, M.A., Ph.D., F.R.S., F.C.S.

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1880 Babington, Charles Cardale, M.A., F.R.S., F.S.A., F.L.S., F.G.S., Professor of Botany in the University of Cambridge, 5, *Brookside, Cambridge.*

1883 Brown, Isaac, *Kendal, Westmoreland.*

1882 Cooke, M. C., M.A., LL.D., A.L.S., 146, *Junction Road, London, N.*

1879 Etheridge, Robert, F.R.S., F.R.S.E., F.G.S., *British Museum (Natural History), South Kensington;* and 14, *Carlyle Square, Chelsea, London, S.W.*

1875 Glaisher, James, F.R.S., F.R.A.S., F.R.M.S., F.R.Met.Soc., Superintendent of the Magnetic and Meteorological Department, Royal Observatory, Greenwich, 1, *Dartmouth Park, Blackheath.*

1879 Harting, James Edmund, F.L.S., F.Z.S., *Linnean Society, Burlington House, London, W.*

1877 Henslow, Rev. George, M.A., F.L.S., F.G.S., Lecturer on Botany, St. Bartholomew's Hospital, *Drayton House, Ealing.*

1875 Hooker, Sir Joseph Dalton, R.N., K.C.S.I., C.B., M.D., D.C.L. (Oxon.), LL.D. (Cantab.), F.R.S., F.L.S., F.G.S., etc., *The Camp, Sunningdale, Berks.*

1883 Huxley, Thomas Henry, D.C.L. (Oxon.), LL.D. (Edin.), Ph.D., F.R.S., F.L.S., F.G.S., F.Z.S., etc., ex-Professor of Natural History in the Royal School of Mines, 4, *Marlborough Place, St. John's Wood, London, N.W.*

1886 Jackson, Benjamin Daydon, Sec. L.S., 2, *Thorncliffe Road, Clapham Park, London, S.W.*

1883 Jones, Thomas Rupert, F.R.S., F.G.S., ex-Professor of Geology at the Royal Military College, Sandhurst, 10, *Uverdale Road, King's Road, Chelsea, London, S.W.*

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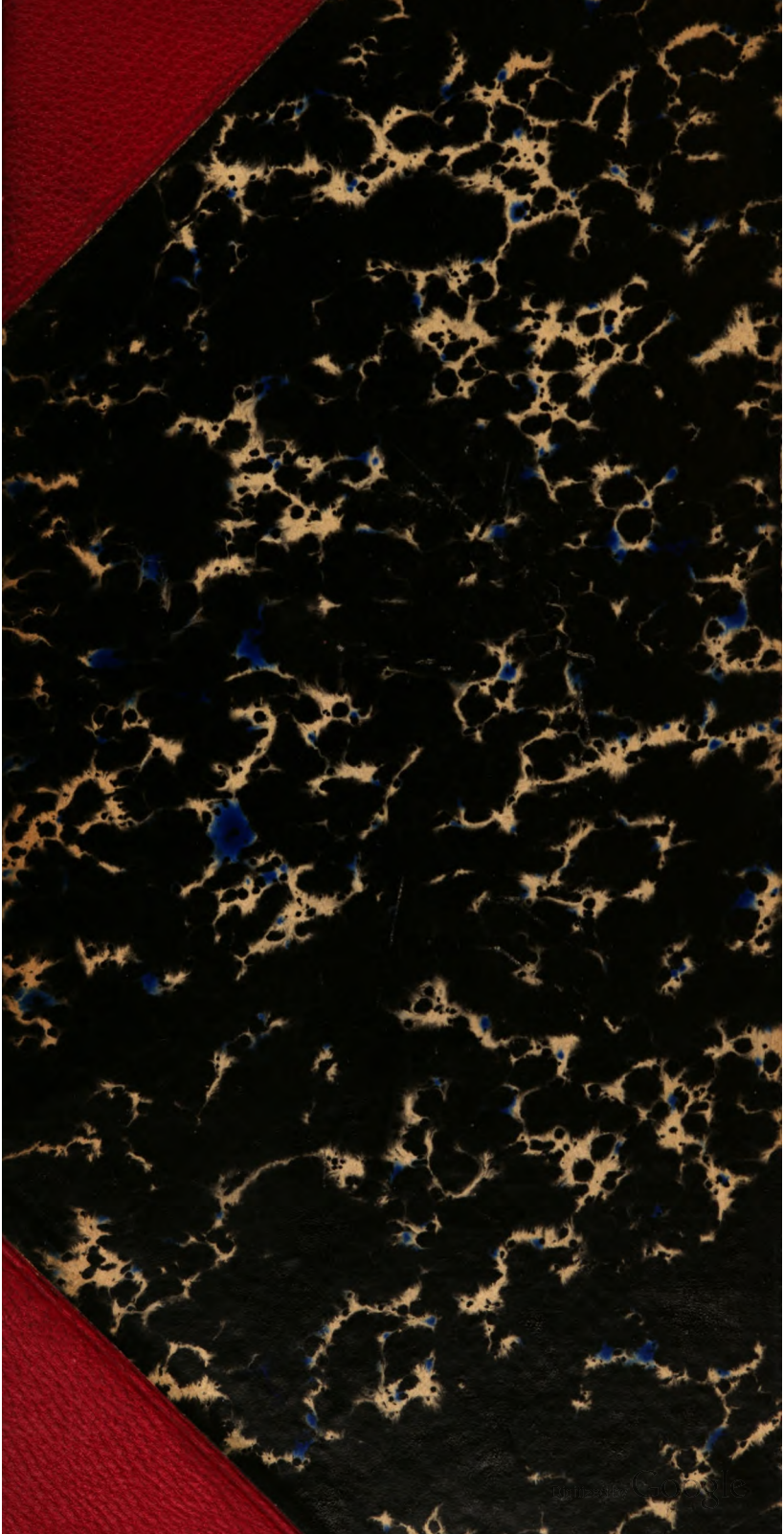
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